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ABSTRACT

This paper reports a medical evaluation of a federal program providing funds for special nutritious food supplements to low income pregnant and lactating women, infants, and children up to four years of age who are nutritional risks. Growth, dietary intake, and biochemical measures were obtained for study infants at the time of enrollment in the program, and after receiving food supplements for 6 and 11 months. Vital statistics, medical complications of pregnancy, weight gain during pregnancy, birth weight of baby, dietary intakes and biochemical indices were the evaluation indices selected for mothers. Mothers were examined at time of enrollment, approximately every three months thereafter until time of delivery, and once after delivery (usually between four and eight weeks postpartum). Results are tabulated and their significance to public health discussed. It is concluded that the program was associated with accelerated growth in weight and height, and reduction of anemia in children. The program impact was greater on black and Spanish American babies than on white babies. Pregnant women participating in the program gained more weight during pregnancy than women in the initial population and had a reduced rate of anemia. (SB)

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MEDICAL EVALUATION OF THE SPECIAL SUPPLEMENTAL FOOD PROGRAM FOR WOMEN, INFANTS AND CHILDREN

SELECT COMMITTEE ON NUTRITION AND HUMAN NEEDS UNITED STATES SENATE

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INTRODUCTION

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This carefully done medical evaluation of the Special Supplemental Food Program for Women, Infants, and Children (WIC), proves that WIC is substantially limiting the savage consequences of poor nutrition during pregnancy and infancy, thereby helping to eliminate much of the tragic human and social costs which accompany low birth weight.

The study, conducted over a 2½ year period, shows that a Federal program of diet supplementation can dramatically improve birth weights, height, head circumference, and reduce anemia among low-income infants and children.

WIC was originally conceived and implemented as the result of much testimony and evidence brought before this committee. Designed to provide timely high-protein nutrition supplements to this high-risk group, WIC is now reaching over 700,000 persons.

Among other things, the study, conducted by the University of North Carolina, concludes that as a result of the WIC Program:

1. there was an increase in height, weight, and head circumference among participating infants;
2. there was a reduction in anemia for mothers and infants;
3. there was an increase in mean corpuscular hemoglobin concentration for infants and children;
4. there was an increase in the consumption of protein, calcium, phosphorous, iron, vitamin A, thiamine, riboflavin, niacin, ascorbic acid and folacin by participating mothers;
5. there was a relative increase in weight gain during pregnancy by participating mothers; and
6. there was a particularly marked increase in the birth weights of minority infants.

Given what we know about the connection between the mother's diet and the infant's birth weight, and the irrefutable linkage between low birth weight and infant mortality, birth defects, and mental retardation, these results are especially gratifying. This program is, at this moment, dramatically improving the health of hundreds of thousands of the most vulnerable among us.

We believe that with the release of this detailed medical evaluation, the WIC program has come of age. Its effectiveness cannot now be doubted. It must no longer be considered a pilot program.

However, the committee will continue to exercise vigorous oversight in the entire area of maternal, fetal and infant nutrition, to both make certain the program is administered fairly and lawfully, and to reform and improve the legislation as indicated by any and all new information that comes to our attention.

There is no program of greater concern to the Nutrition Committee, nor one with potential for doing any greater good, than the WIC program.

GEORGE MCGOVERN, *Chairman.*
CHARLES H. PERCY.

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MEDICAL EVALUATION OF THE SPECIAL SUPPLEMENTAL FOOD PROGRAM FOR WOMEN, INFANTS, AND CHILDREN[1]

SUMMARY AND CONCLUSIONS

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UNIVERSITY OF NORTH CAROLINA

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[1] A report by Joseph C. Edozien, M.D., Boyd R. Switzer, Ph. D., and Rebecca B. Bryan, M.P.H., Department of Nutrition, School of Public Health, University of North Carolina, Chapel Hill, N.C., July 15, 1978.

NOTE.—The Report of the WIC Medical Evaluation consists of three parts: Volume I—Study Design, Methods and Performance Data; Volume II—Results; and Volume III—Summary and Conclusions. Volumes I and II can be obtained by writing to the Department of Nutrition, School of Public Health, University of North Carolina, Chapel Hill, N.C. The research for this publication was carried out under Contract Number FNS 12-35-600-141 with Food and Nutrition Service, U.S. Department of Agriculture. Opinions expressed are those of the authors and do not necessarily represent the views of the Department of Agriculture, The University of North Carolina at Chapel Hill or the consultants to the project. The data processing, statistical computations, and statistical advice were supplied by The Research Triangle Institute. Drs. W. Kenneth Poole, and A. Vijaya were the statisticians for the study.

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BACKGROUND

The Special Supplemental Food Program for Women, Infants and Children (WIC program), authorized by a September 26, 1972 amendment (Public Law 92–433; 86 Stat 724) to the Child Nutrition Act of 1966 (42 U.S.C. 1786), provided cash grants to State health departments and approved local health clinics for the purpose of providing special nutritious food supplements to low income pregnant and lactating women, infants and children up to 4 years of age who are nutritional risks. The program is administered by the Food and Nutrition Service of the United States Department of Agriculture.

Under the program infants under 1 year of age were allowed iron-fortified formula, iron-fortified cereal and fruit juices while 1- to 3-year-old children and women were provided milk, eggs, iron-fortified cereal and fruit juices. The food packages were thus designed to correct known inadequacies of iron, vitamin A and vitamin C in the diets of low income individuals in the country.

In order to fulfill the congressional mandate to assess the benefits of the WIC program, the Department of Agriculture contracted, on November 28, 1973, with the University of North Carolina at Chapel Hill for the Department of Nutrition, School of Public Health to perform a detailed medical evaluation of the program. The study was carried out between November 28, 1973 and June 1, 1976.

Participating in the detailed medical evaluation were 19 projects located in 14 States. The projects and States were: Alabama (Coffee County); Arizona (Coconino County and Pima County); Connecticut (Stamford); Indiana (Indianapolis); Minnesota (Minneapolis and Bemidji); Mississippi (Sharkey-Issaquena County); Missouri (Kirksville); New Jersey (Newark); New York (Nena Health Council); Ohio (Cleveland and Dayton); South Carolina (Lancaster County); Texas (Robestown near Corpus Christi, Cameron County, Hidalgo County); Vermont (statewide) and Wisconsin (Great Lakes Intertribal Council, Lac du Flambeau). Two of the projects (Kirksville and Dayton) provided data only for infants 1 year of age while one other project (Bemidji) provided data for infants and children of all ages (0–48 months) but not for women. The locations of the projects are shown in Figure 1.

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The participants lived mostly in urban locations; 91.6 percent were urban, 2.6 percent rural farm and 6 percent rural non-farm. They came predominantly from very low income households having an average yearly after-tax income of $3,757. The average household size was 4.6 persons. About 66.1 percent of the households fell below the OEO Income Poverty Guideline which is widely used to classify low-income families for eligibility for various welfare programs. At least 84.2 percent of the households were found to be eligible for food stamps when the USDA "Food Stamp * * * Eligibility Requirements" were applied to them.

Methods

The basic operational plan was to obtain information on selected measures of the nutritional status of the study population, initially and after participation in the program for a specified interval. Comparisons of the results of measurements taken before and after program participation provided an estimate of the impact of the program.

The infants and children were examined at the time of enrollment and after receiving food supplements for 6 and 11 months. The indices selected for their assessment were:

1. Growth. Weight, height and head circumference were the body measurements taken. A weight/height (Nutritional) index was calculated as

$$\frac{\text{weight in kg}}{\text{height in cms}^{1.8}} \times 10^4.$$

This ratio was used to monitor weight for height changes associated with the program.

2. Dietary intakes. Dietary data were obtained on 25 percent of the infants and children initially, and from the same subjects at the time of their 6 month and 11 month revisits.

3. Biochemical indices. The parameters of interest were: hemoglobin, hematocrit, mean corpuscular hemoglobin concentration (MCHC), total plasma iron, plasma transferrin, percent saturation of plasma transferrin (PSAT), plasma complement 3 (C3), plasma immunoglobulins A, G and M (IgA, IgG, IgM), plasma albumin, total plasma protein, plasma cholesterol, and plasma folacin. Blood was collected by finger or heel stick from all participants and at all visits.

The women were examined at the time of enrollment and thereafter approximately every 3 months until the time of delivery. Each woman was also examined once after delivery usually between 4 and 8 weeks postpartum. The indices selected for their evaluation were:

1. Vital statistics (abortion and miscarriage rate, stillbirth rate, prematurity rate, low birth weight rate and infant mortality.

2. Medical complications of pregnancy (edema, proteinuria, hypertension, convulsions).

3. Weight gain during pregnancy (total amount as well as the rate of gain).

4. Birth weight of the baby.

5. Dietary intakes. Dietary data were obtained from half of the participants initially and from the same participants at all follow-up visits.

6. Biochemical indices. The parameters of interest were: hemoglobin, hematocrit, mean corpuscular hemoglobin concentration (MCHC), total plasma iron, plasma transferrin, percent saturation of transferrin (PSAT), plasma complement 3 (C3), plasma immunoglobulins A, G and M (IgA, IgG, and IgM), plasma albumin, total plasma proteins, plasma cholesterol, plasma vitamin A, plasma carotene, plasma vitamin C and plasma folacin. Blood was collected from all participants at all visits.

The methods and procedures used for making the above measurements are described in Volume I, Part 1, of the report. Standard methods were used for obtaining the clinical and anthropometric data. Daily intakes of nutrients were obtained from 24-hour recall data. A modified dietary history method was used to obtain information on food use as well as the usual daily nutrient intakes of individuals for correlating biochemical values and dietary intakes. Standard laboratory procedures were also chosen for all biochemical measurements except for saturation of transferrin; however, some methods had to be modified to make them suitable for processing the small amount of plasma collected from infants and children.

The percent saturation of transferrin was calculated from the equation,

$$\text{Percent Saturation of Transferrin} = \frac{\text{Plasma Iron}}{1.25 \times \text{Plasma Transferrin}} \times 100.$$

Transferrin itself was determined nephelometrically in an Autoanalyzer II by an automated immunochemical method. This procedure provided results for saturation of transferrin which were comparable to those obtained by direct measurement of total iron binding capacity. As an illustrative example, a mean saturation of transferrin value of 25.9 ± 15.5 percent was obtained on 191 randomly selected plasma samples by the standard procedure while the transferrin method gave a mean value of 26.3 ± 18.0 percent; the difference is not statistically significant at the 0.05 level ($.7 < p < .9$) and the coefficient of correlation is 0.89.

Since the values obtained for most of the measurements which were selected can be influenced by medical, racial, socio-economic and other environmental variables, as well as by nutritional factors, data relating to such variables as location of residence, household size, race, income and sex were also collected. Most of the parameters of interest also change with time because of age, in the case of the infants and children, and the progress of pregnancy, in the case of women. Hence, the evaluation was not one in which each participant could be his/her own control. It was essential to have either a carefully matched group for simultaneous time control or to establish suitable baseline conditions for meaningful interpretation of the data. The latter alternative was chosen for this study and accordingly baseline values were established for all age and pregnancy duration groups of interest by analyses of the results of measurements made on each individual before he/she began receiving food supplements. During data analyses, age, sex (for infants and children), duration of pregnancy or postpartum (for the women), ethnic origin and income poverty ratio were routinely included in regressions as independent variables whenever groups of varying characteristics were being compared. Collection of initial data from new participants was continuous throughout the duration

of the study and data were analyzed according to the date of collection in order to document possible changes in baseline conditions.

The principal descriptive measures used in presenting the results are means and standard deviation, distributions and percent above or below specified levels. The statistical significance of differences between groups or of change within the same group before and after program participation is mostly indicated by a P value which is the probability value associated with the F-statistic for testing the differences after adjusting for all other factors which were taken into account. The corrected differences themselves are generally shown as the differences between the adjusted means. In some instances the differences between the initial and subsequent measurements (Δ's) were calculated directly for each individual and the mean of these differences was obtained for groups. Such an approach was used when the differences were the parameters of primary interest as in the case of weight gained during pregnancy; otherwise, it was often used to check estimates of program impact obtained by calculation of differences between adjusted mean values. Differences were considered significant for $p<0.05$.

Infants and Children

In the course of the evaluation a total of 41,300 infants and children were examined. Eleven thousand three hundred and ninety of these participants were re-examined after 6 months of receiving food supplements and 6,256 after 11 months in the program. A return rate of 49.1 percent was achieved for the 6-month evaluation and 43.9 percent for the 11-month visit. The participants were approximately 21 percent white, 34 percent black, 42 percent Spanish American and 3 percent American Indian.

The average birth weight of the infants and children was about 3,225 grams (both sexes) and this was considered to be about 125 grams less than the standard (*1*). After birth, they continued to be slightly retarded in growth; there were, for instance, about 50 percent more infants and children than expected below the 10th percentile for weight and height and about twice the expected percentage below the 10th percentile for head circumference (Volume II, Part 2, Tables 7a and 7b). The results also confirm other reports that, although black babies had lower birth weights than those of other ethnic groups, black infants have the fastest growth rate so that by 3 to 6 months of age they were taller than infants of other ethnic groups (Volume II, Part 2, Figures 1 and 3).

The average daily iron intakes of 6- to 11-month-old infants and children were initially less than the Recommended Dietary Allowances (RDA); otherwise the initial nutrient intakes of infants and children either equalled or exceeded the RDA (table 1). The daily intakes of protein, calcium, phosphorus and riboflavin of participating 6- to 11-month-old infants were reduced while their intakes of iron, vitamin A, thiamine and ascorbic acid increased (table 2). In contrast to the infants, participating children increased their daily consumption of all nutrients except energy (table 2).

Location of Projects Participating in the Detailed Medical Evaluation of the WIC Program

FIGURE 1

TABLE 1.—INITIAL NUTRIENT INTAKES OF INFANTS AND CHILDREN OBTAINED BY 24-HR RECALL

Nutrient [1]	Mean	SD	RDA [2]	Percent low [3]	Percent high [4]
6 to 11 months N=907:					
Energy: kcals/kg	170	51	108	16	27
Energy: kcals	1,037	403			
Protein: g/kg	4.9	2.4	2.0	2	92
Protein: g	42.6	19.6			
Calcium: mg	1,019	499	540	5	83
Phosphorus: mg	970	425	400	2	93
Iron: mg	11.1	9.5	15	53	28
Vitamin A: IU	3,932	2,664	2,000	5	78
Thiamine: mg	.81	.45	.5	4	73
Riboflavin: mg	1.68	.79	.6	2	95
Niacin: mg	7.7	5.0	8	30	40
Ascorbic acid: mg	60	50	35	26	59
12 to 23 months N=1403:					
Energy: kcals/kg	117	45	100	14	35
Energy: kcals	1,290	487	1,100		
Protein: g/kg	4.8	2.0	1.9	1	96
Protein: g	52.9	21.0	23		
Calcium: mg	904	484	800	15	54
Phosphorus: mg	1,009	423	800	7	65
Iron: mg	7.8	5.9	15	68	9
Vitamin A: IU	3,217	2,098	2,000	7	69
Thiamine: mg	.83	.64	.7	8	55
Riboflavin: mg	1.65	.73	.8	2	98
Niacin: mg	8.5	5.0	9	24	27
Ascorbic acid: mg	64	59	40	31	52
24 to 35 months N=1287:					
Energy: kcals/kg	100	45	100	18	29
Energy: kcals	1,417	537	1,300		
Protein: g/kg	4.2	1.9	1.8	2	94
Protein: g	54.7	22.5	23		
Calcium: mg	784	470	800	25	42
Phosphorus: mg	960	431	800	9	60
Iron: mg	7.9	4.4	15	61	6
Vitamin A: IU	3,233	2,344	2,000	11	67
Thiamine: mg	.91	.45	0.7	8	66
Riboflavin: mg	1.55	.70	0.8	4	85
Niacin: mg	9.7	5.3	9	16	58
Ascorbic acid: mg	73	68	40	28	56
36 to 47 months N=872:					
Energy: kcals/kg	98.6	42.4	100	15	19
Energy: kcals	1,450	553	1,300		
Protein: g/kg	3.7	1.7	1.8	2	91
Protein: g	54.3	21.7	23		
Calcium: mg	734	415	800	26	37
Phosphorus: mg	939	396	800	8	62
Iron: mg	8.2	4.5	15	58	7
Vitamin A: IU	3,266	2,465	2,000	11	66
Thiamine: mg	.93	.46	.7	6	68
Riboflavin: mg	1.50	.71	.8	3	84
Niacin: mg	10.4	5.7	9	4	54
Ascorbic acid: mg	76	68	40	2	59

[1] Nutrient intakes are in stated units/day.

[2] The RDA has been used in a number of different ways for interpreting dietary intake data: (1) The nutrient intakes of individuals are often compared to the RDA. This procedure assumes that the intake of each individual should be ≥ RDA. This kind of comparison is analogous to the assumption that every child should be above the 50th percentile in weight and height for age. It may be useful for the evaluation of individuals since intake of an amount of nutrient ≥ RDA ensures that in 97.5 percent of cases the individual has an adequate intake of the nutrient. It is not appropriate for the assessment of the nutritional status of a large population; the mean intake for the population would have to be well above the RDA (about 21/2 to 3 times RDA) to ensure that every person's intake is ≥ RDA. (2) The RDA may be taken to represent (the average nutrient requirement) plus 2 (a safety allowance) plus 2 SD's i.e., for a large population the RDA represents the 97.5th percentile of the requirements of individuals in that population except for energy where it represents the 50th percentile because 2 SD's were not added. This is the procedure used in deriving the RDA in the first instance and presents the best approach for using the RDA to evaluate the adequacy of nutrient intakes for a large population. In this study nutrient intakes were analyzed according to percentages below (or above) specified levels. The levels selected were 130, 100 and 70 percent of RDA for energy and 100, 77 and 54 percent of RDA for other nutrients. These levels should represent 97.5, 50 and 2.5 percentiles of a normal distribution of recommended nutrient intakes. (3) The mean or median intake for a population is sometimes compared to the RDA. This interpretation is useful for estimating the average nutrient needs for the population. In reality, the mean or median intakes should be compared to the RDA for energy and 77 percent of RDA for other nutrients. The 77 percent standard is derived from the equation, RDA = mean ÷ (2 × 15 × 100 × mean) = 1.3 × mean and assumes that individual variation in nutrient intakes is usually about ± 15 percent (2). The use of the RDA rather than 77 percent of RDA introduces only a slight error while greatly simplifying the calculations.

The second and third procedures were used in this study. They generally provide comparable results. The first procedure i.e., direct comparison of the intake of each individual to the RDA, greatly overestimates the percentage of individuals who may not be meeting their nutrient requirements.

[3] Percentage below 70 percent of RDA for energy or below 54 percent of RDA for other nutrients. Only 2.5 percent of the population should be in this category.

[4] Percentage above 130 percent of RDA for energy or above 100 percent of RDA for other nutrients. Only 2.5 percent of the population should be in this category.

TABLE 2.—EFFECT OF PARTICIPATION IN THE WIC PROGRAM ON THE NUTRIENT INTAKES OF INFANTS AND CHILDREN [1]

Nutrient [2]	P_0 [3]	Δ_0 [4]	P_{11} [3]	Δ_{11} [4]
6 to 11 mo:	0.7982			
Energy	.0001	−6.8		
Protein	.0001	−127		
Calcium	.0001	−121		
Phosphorus	.0001	+5.1		
Iron	.0294	+.05		
Vitamin A	.9001	+.15		
Thiamine	.0001	−.19		
Riboflavin	.0001	+2.36		
Niacin	.0001	+.19		
Ascorbic acid	.0001			
12 to 47 mo:	.2653		0.9714	
Energy	.0001	+2.8	.0001	+3.6
Protein	.0001	+.05	.0001	+.73
Calcium	.0001	+.72	.0001	+.67
Phosphorus	.0001	+1.6	.0001	+1.5
Iron	.0001	+.512	.0001	+.627
Vitamin A	.0001	+.14	.0001	+.17
Thiamine	.0001	+.21	.0001	+.27
Riboflavin	.0001	+.64	.0001	+1.15
Niacin	.0003	+.22	.0001	+.28
Ascorbic acid	.0001	+.31	.0001	+.34
Folacin, μg/day	.0001			

[1] The number of records examined were as follows:

Age group	Initial	6 mo	11 mo
6 to 11	812	506	1,088
12 to 47	3,584	1,292	4,068

[2] Daily amounts are in kcals for energy, g. for protein, International units (IU) for vitamin A and mg. for all others unless stated otherwise.

[3] Probability values after adjusting for age, sex, ethnic origin, income poverty ratio and project location.

[4] Increase (+) or decrease (−) in adjusted mean values at the time of the 6-mo or 11-mo visits as compared to the initial values. The means were adjusted for age, sex, ethnic origin, income poverty ratio and project location.

Note: Δ's given in this report represent differences between mean values which have been adjusted for all factors in the regression analysis other than the factor under consideration. The independent variables in the regression are usually specified in a footnote to the P value.

Participation in the WIC program was associated with an increase in the rate of growth in weight and height in all age groups; the effect was least in 6- to 11-month-old infants and greatest in 36- to 41-month-old children (Table 3, Figures 2 and 3). A comparison of group mean values at initial and follow-up visits indicated that there was an increase in head circumference of infants and children at the time of the 6-month visit; the increase in children occurred primarily in the 12- to 17-month age group. When the data were analyzed to compare the observed average growth increments for a specified time period to the expected average growth increment for the same time period, it became evident that the increase in head circumference occurred primarily in infants enrolled within 1 month of birth (Figures 2 and 3);

TABLE 3.—RESULTS OF REGRESSION ANALYSIS OF DATA FROM ALL 6- TO 48-MO-OLD INFANTS AND CHILDREN TO MEASURE THE EFFECT OF 6 AND 11 MO PARTICIPATION IN THE WIC PROGRAM ON WEIGHT, HEIGHT, HEAD CIRCUMFERENCE AND NUTRITIONAL INDEX

Age group and measurement	Summary of effect		
	P[1]	Δ_1[2]	Δ_2[3]
(a) 12 to 47 mo:			
Weight	0.0001	+240 g	+113 g.
Height	.0001	+0.51 cm	+0.56 cm.
Head circumference	.0162	+0.09 cm	+0.02 cm.
Nutritional index	.0101	+0.96	−0.06.
Data set had 19,711 visits consisting of 10,947 initial; 5,088 6-mo; and 3,676 11-mo visits.			
(b) 6 to 11 mo:			
Weight	.0015	+123 g	
Height	.0236	+0.23 cm	
Head circumference	.0288	+0.13 cm	
Nutritional index	.0130	+0.8	
Initial visits—2,756; 6-mo visits—1,983.			
(c) 12 to 17 mo:			
Weight	.0003	+221 g	+143 g.
Height	.0005	+0.55 cm	+0.51 cm.
Head circumference	.0004	+0.32 cm	+0.12 cm.
Nutritional index	.0332	+1.0	+0.4.
Initial visits—2,122; 6-mo visits—1,025; 11-mo visits—860.			
(d) 18 to 23 mo:			
Weight	.0991	+173 g	+163 g.
Height	.6797	+0.25 cm	+0.39 cm
Head circumference	.5873	−0.08 cm	0 cm.
Nutritional index	.0674	+1.0	+0.5.
Initial visits—2,1 .; 6-mo visits—811; 11-mo visits—627.			
(e) 24 to 29 mo:			
Weight	.0101	+353 g	+180 g.
Height	.0961	+0.02 cm	+0.01 cm.
Head circumference	.4810	+0.10 cm	+0.03 cm.
Nutritional index	.0117	+1.2	0.
Initial visits—1 955; 6-mo visits—843; 11-mo visits—541.			
(f) 30 to 35 mo:			
Weight	.0021	+160 g	+88 g.
Height	.1032	+0.21 cm	+0.48 cm.
Head circumference	.0003	+0.04 cm	+0.01 cm.
Nutritional index	.0015	+0.9	−0.1.
Initial visits—1,893; 6-mo visits—823; 11-mo visits—566.			
(g) 36 to 41 mo:			
Weight	.0519	+213 g	+101 g.
Height	.0329	0.49 cm	0.48 cm.
Head circumference	.8621	0 cm	0.05 cm.
Nutritional index	.2564	+0.7	−0.1.
Initial visits—1,709; 6-mo visits—705; 11-mo visits—512.			
(h) 42 to 47 mo:			
Weight	.0010	+169 g	+256 g.
Height	.0010	+1.3 cm	+1.4 cm.
Head circumference	.1141		
Nutritional index	.0017	+1.5	−0.5.
Initial visits—1,708.			

[1] P value is probability after adjusting for age, sex, ethnic origin, income poverty ratio, birth weight, difference in weight of growth curve between low-birth weight and normal-birth weight babies (PW) and difference in slope of the growth curves of the above 2 categories of infants and children (SWT$_2$).
[2] Increase (+) or decrease (−) of adjusted means at the time of the 6-mo visit as compared to initial value.
[3] Increase (+) or decrease (−) of adjusted means at the time of 11-mo visit as compared to initial value.

EFFECTS OF THE WIC PROGRAM ON GROWTH OF ALL INFANTS AND CHILDREN

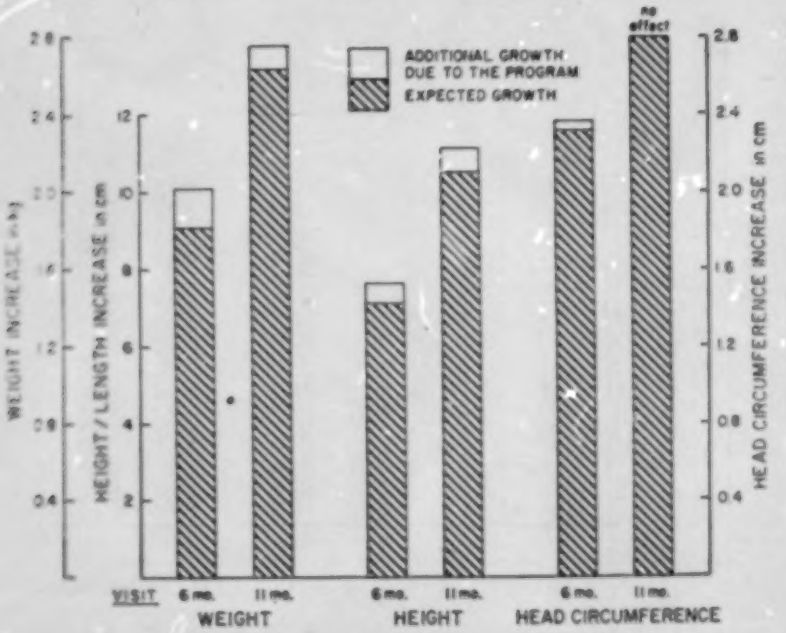


FIGURE 2.—Calculated individual gains compared to age-, sex-, ethnic-specific initial growth rates for the same infants and children. Data set consisted of 9,143 subjects who had the initial and 6-month visits and 5,209 infants and children who made the initial and 11-month visits. The increase in weight is significant after 6 months ($p<.001$) and after 11 months ($p<.001$); the increase in height was also significant after 6 months ($p<.001$) and after 11 months ($p<.001$). The differences in head circumference are not statistically significant.

75-123--76----3

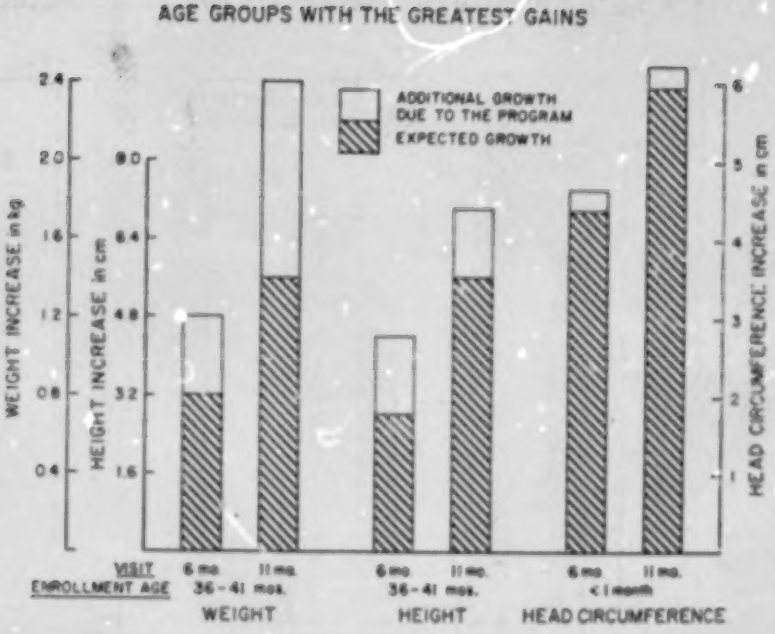


FIGURE 3.—Calculated individual gains for 855 infants less than 1 month old and 917, 36- to 41-month-old children. All differences are statistically significant ($p<.05$).

At the time of the 6-month evaluation there was an increase in the Nutritional Index indicating that the participants became relatively heavier for their height but this parameter returned to the initial value by the time of the 11-month evaluation (Table 3). Therefore, the program did not appear to have contributed to the problem of overweight (i.e., excess weight for a given height) in this population after the first 6 months of participation.

Anemia was highly prevalent among the infants and children investigated. About 26 percent of all those beyond the age of 3 months had a hemoglobin concentration below 11 g/100 ml of blood. After 6 months in the program the incidence of anemia was cut by about 40 percent in all age groups (Figure 4). There was a further decrease in anemia rate in 12- to 23-month-old children when they were again examined after a total of 11 months in the program. The changes in blood hemoglobin were associated with the WIC food package since hemoglobin level at the time of follow-up visits was related to the percentage of the food package received by participants (Table 4).

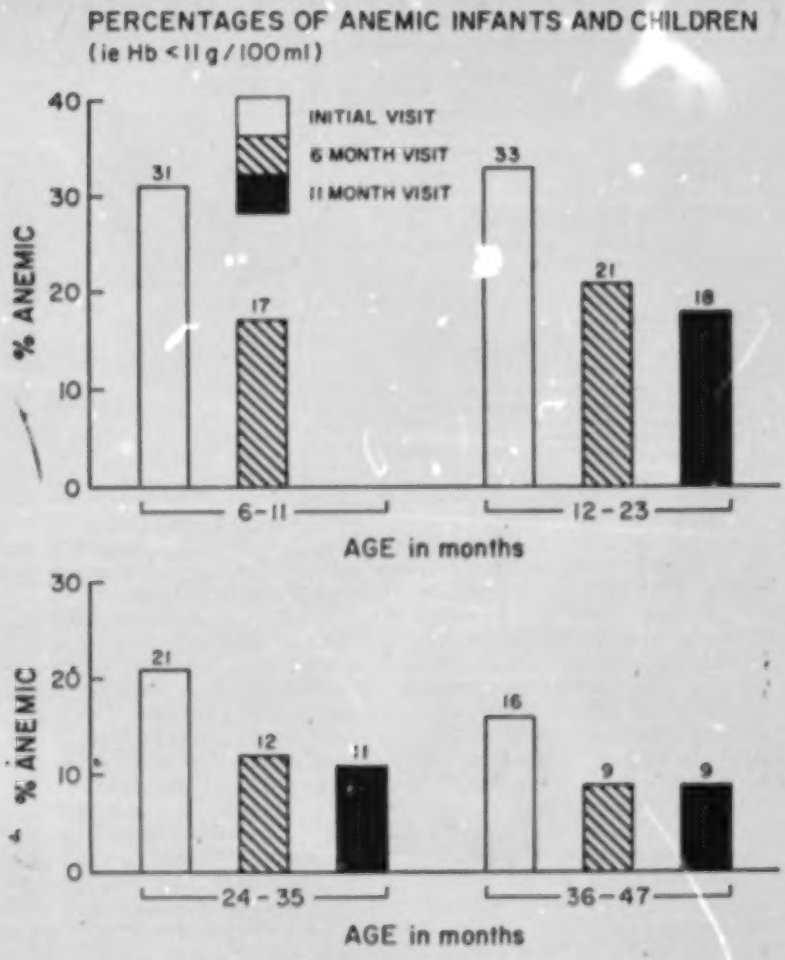


FIGURE 4.—Number of participants:
Age 6–11 months: Initial 3363, 6-month 2705, 11-month 0.
Age 12–23 months: Initial 5633, 6-month 2732, 11-month 1961.
Age 24–35 months: Initial 5301, 6-month 2538, 11-month 1523.
Age 36–47 months: Initial 4025, 6-month 2338, 11-month 1426.
Age 12–47 months: Initial 14976, 6-month 7608, 11-month 4910.
The differences between initial and 6-month visit values are statistically significant for all age groups. The difference between 6-month and 11-month visit values is significant for only 12–23 months old children.

TABLE 4.—RESULTS OF REGRESSION ANALYSES TO SHOW THE RELATIONSHIP OF BODY WEIGHT, BLOOD HEMOGLOBIN, PLASMA C3 AND PLASMA IGG TO THE WIC FOOD PACKAGE

Variable	DF	P values[1] Weight	Blood hemoglobin	Plasma C3	Plasma IgG
A. P values:					
Food package	2	0.5501	0.0807	0.2258	0.3955
Duration of feeding[2]	1	.1125	.0001	.0001	.0001
Age group	5	.0001	.0001	.0001	.0001
Sex	2	.7301	.2150	.2913	.0001
Ethnic origin	3	.0001	.0001	.0001	.0001
FPB	9	.1756	.0001	.0001	.0001

Food package: Percent of maximum eligibility	Weight kg	Hemoglobin g/100ml	Plasma C3 mg/100ml	Plasma IgG mg/100ml
Adjusted mean values[3]:				
1 to 49	15.8(259)	[4] 12.7(246)	86(170)	867(147)
50-75	16.0(989)	12.7(879)	82(625)	899(547)
76-100	15.9(11,063)	12.9(10,752)	83(7,485)	901(6,946)

[1] Values after adjustments for all other factors in the regression.
[2] Adjustment for differences between values at 6- and 11-month visits.
[3] Includes a category of unknown.
[4] Figures in parentheses represent number of participants.

The indices of iron nutriture provided varying estimates of the prevalence of iron deficiency. The saturation of transferrin values suggested that iron deficiency was about 50 percent more prevalent than anemia itself while the mean corpuscular hemoglobin concentration (MCHC) results gave much lower estimates (table 5).

Participation in the program was consistently associated with an increase in mean MCHC values and a decrease in the percentage of infants and children having MCHC values below 30 g/100 ml (tables 5 and 6). The saturation of transferrin values did not show a consistent trend. In the infants there was no change in mean saturation of transferrin values but there was a small decrease in the percentage of participants having unsatisfactory results. When the children were evaluated after 6 months in the program, they showed a small decrease in mean values for saturation of transferrin and an increase in the percentage having unsatisfactory results but by the time of the 11-month evaluation their mean saturation of transferrin had returned to the initial value and there was a decline in the percentage who had unsatisfactory results. Evidently, the consistent increase in mean hemoglobin values and reduction in the anemia rate were paralleled by similar changes in MCHC but not by changes in saturation of transferrin.

TABLE 5.—EFFECT OF THE WIC PROGRAM ON THE PREVALENCE OF ANEMIA AND OF UNSATISFACTORY INDICES OF IRON NUTRITURE

Variable	Initial visit N	6-mo visit N	11-mo visit N	Initial percent unsatisfactory	P_6[1]	Δ_6[1,4]	P_{11}[2]	Δ_{11}[2,4]
6 to 11 mo:								
Hemoglobin <11 g/100 ml	3,363	2,705	----------	31.0	0.0001	−14.1	----------	----------
Hematocrit <33 percent	3,363	2,705	----------	19.0	.0001	−5.9	----------	----------
MCHC <30 g/100 ml	3,363	2,705	----------	14.0	.0001	−7.2	----------	----------
Total iron <40 μg/100 ml	2,316	2,040	----------	19.0	.3147	----------	----------	----------
Transferrin >400 mg/100 ml	2,316	2,040	----------	34.0	.0001	−10.7	----------	----------
PSAT <15 percent	2,316	2,040	----------	54.0	.0026	−4.6	----------	----------
12 to 23 mo:								
Hemoglobin <11 g/100 ml	5,633	2,732	1,961	33.0	.0001	−11.9	0.0001	−15.2
Hematocrit <33 percent	5,633	2,732	1,961	19.0	.0001	−7.5	.0001	−9.7
MCHC <30 g/100 ml	5,633	2,732	1,961	17.0	.0001	−5.1	.0001	−7.6
Total iron <40 μg/100 ml	3,926	2,141	1,584	19.0	.0087	+2.8	.5316	----------
Transferrin >400 mg/100 ml	3,926	2,141	1,584	42.0	.4018	----------	.0001	−14.6
PSAT <15 percent	3,926	2,141	1,584	51.0	.0327	+2.6	.0005	−5.1
24 to 35 mo:								
Hemoglobin <11 g/100 ml	5,301	2,538	1,523	21.0	.0001	−9.3	.0001	−9.9
Hematocrit <33 percent	5,301	2,538	1,523	12.0	.0001	−5.6	.0001	−5.6
MCHC <30 g/100 ml	5,301	2,538	1,523	12.0	.0001	−4.1	.0001	−4.5
Total iron <40 μg/100 ml	3,760	1,962	1,247	10.0	.0210	+2.1	.2744	+1.1
Transferrin >400 mg/100 ml	3,760	1,962	1,247	25.0	.0167	−2.7	.0001	−10.0
PSAT <15 percent	3,760	1,962	1,247	31.0	.0078	+3.4	.2987	----------
36 to 47 mo:								
Hemoglobin <11 g/100 ml	4,025	2,338	1,426	16.0	.0001	−7.3	.0001	−7.2
Hematocrit <33 percent	4,025	2,338	1,426	9.0	.0001	−4.5	.0001	−4.6
MCHC <30 g/100 ml	4,025	2,338	1,426	9.0	.0001	−4.3	.0001	−3.9
Total iron <40 μg/100 ml	2,883	1,357	1,179	6.0	.0084	+2.0	.0312	+2.0
Transferrin >400 mg/100 ml	2,883	1,357	1,179	12.0	.9950	----------	.0001	−8.5
PSAT <15 percent	2,883	1,357	1,179	21.0	.0222	+2.9	.1147	----------
12 to 47 mo:								
Hemoglobin <11 g/100 ml	14,976	7,608	4,910	23.1	.0001	−9.7	.0001	−11.0
Hematocrit <33 percent	14,976	7,608	4,910	12.8	.0001	−5.3	.0001	−6.4
MCHC <30 g/100 ml	14,976	7,608	4,910	12.7	.0001	−4.6	.0001	−5.6
Total iron <40 μg/100 ml	10,581	5,979	4,011	12.5	.0003	+2.3	.3546	----------
Transferrin >400 mg/100 ml	10,581	5,979	4,011	29.6	.0695	----------	.0001	−14.2
PSAT <15 percent	10,581	5,979	4,011	36.4	.0001	+3.0	.0062	−3.3

[1] Change, increase (+) or decrease (−), at 6-mo visit in percentage of infants and children with values above or below specified level after adjusting for age, sex, race, and income poverty ratio.

[2] Change, increase (+) or decrease (−) at 11-mo visit in percentage of infants and children with values above or below specified level after adjusting for age, sex, race, and income poverty ratio.

[3] P value for significance of change at 6 and 11 mo after adjusting for age, sex, race, and income poverty ratio.

[4] The results represent changes in percentage points and not percent change, e.g., Δ_6 of −9 from an original value of 31 percent means a decrease to 22 percent, i.e., a decrease of about 30 percent.

TABLE 6.—EFFECT OF THE WIC PROGRAM ON MEAN HEMATOLOGICAL VALUES OF PARTICIPATING INFANTS AND CHILDREN

Variable	Initial visit N	6-mo visit N	11-mo visit N	P_6[1]	Δ_6[1]	P_{11}[1]	$\Delta 11$[1]
6 to 11 mo:							
Hemoglobin	3,363	2,705	----------	0.0001	+.3 g/100 ml		
Hematocrit	3,363	2,705	----------	.0001	+.61 percent		
MCHC	3,363	2,705	----------	.0001	+.51 g/100 ml		
Total iron	2,316	2,040	----------	.4248	----------		
Transferrin	2,316	2,040	----------	.0001	−19.0 mg/100 ml		
PSAT	2,316	2,040	----------	.2957	----------		
12 to 47 mo:							
Hemoglobin	14,959	7,608	4,910	.0001	+.34 g/100 ml	0.0001	+.42 g/100 ml
Hematocrit	14,959	7,608	4,910	.0001	+.79 percent	.0001	+.78 percent
MCHC	14,959	7,608	4,910	.0001	+.24 g/100 ml	.0001	+.49 g/100 ml
Total iron	10,569	5,980	4,012	.0376	−1.3 μg/100 ml	.2149	----------
Transferrin	10,569	5,980	4,012	.0181	+2.9 mg/100 ml	.0001	−2.8 mg/100 ml
PSAT	10,569	5,980	4,012	.0001	−1.3 percent	.7931	----------

[1] P values after adjusting for age, sex, ethnic origin and income poverty ratio.

[2] Δ's = differences between initial and stated revisits. + indicates increase at the time of visit as compared to initial value, − indicates a reduction.

The data suggested that most of the increase in hemoglobin may be part of the accelerated growth response since it was found that blood hemoglobin was strongly related to body weight; part of the increase may be associated with a fall in the plasma level of C3 since blood hemoglobin concentration in the initial population was also related to the plasma level of this specific protein (Table 7). The consistent increase in mean corpuscular hemoglobin concentration suggested that the program may have improved the iron nutriture of the participants. It is possible that a part of the increase in hemoglobin level resulted from an increase in the body's iron stores which showed up in the MCHC but was not reflected in the saturation of transferrin. Body weight in infants and plasma C3 in both infants and children were more highly correlated with saturation of transferrin than with MCHC (Tables 8a and 8b); therefore, in circumstances in which body weight and plasma C3 were also changing, the MCHC may reflect changes in iron nutriture which may not be shown by the saturation of transferrin. A study of changes in plasma ferritin concentration might have provided a reliable indication of shifts in the body's iron stores and this would have made a complete assessment of the role of the iron supplement in the WIC food package possible.

TABLE 7.—THE RESULTS OF MULTIPLE REGRESSION ANALYSIS TO SHOW THE RELATIONSHIP OF BLOOD HEMOGLOBIN CONCENTRATION TO WEIGHT, SATURATION OF TRANSFERRIN, C3, AGE, SEX, RACE, AND INCOME P/JVERTY RATIO

Independent variable	DF	P
Weight	1	0.0001
Saturation of transferrin	1	.0031
C3	1	.0485
Age group	9	.0001
Sex (boy, girl, unknown)	2	.1335
Ethnic origin	5	.0001
IPR	5	.7514

NOTES

Blood hemoglobin concentration is the dependent variable.
The data set consisted of the 8,550 infants and children for whom all relevant data were available.

TABLE 8a.—CORRELATION COEFFICIENTS BETWEEN INITIAL VALUES OF WEIGHT AND SELECTED BIOCHEMICALS IN BLOOD OF INFANTS

	Weight	C3	Hb.	MCHC	SAT	IgG
Weight	[1] 1.00		−0.19	−0.07	−0.48	0.07
	[2] 0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	[3] 11,537	4,074	11,297	10,906	7,083	3,658
C3	[1] .35	1.00	−0.09	−0.07	0.41	0.75
	[2] 0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
	[3] 4,074	4,074	4,023	3,936	3,902	2,741
Hb	[1] −.19	−0.09	1.00	0.39	0.3	0.21
	[2] 0.0001	0.0001	0.0000	0.0001	0.0001	0.0001
	[3] 11,297	4,023	11,297	10,906	6,984	3,628
MCHC	[1] −.06	−0.07	0.39	1.00	0.08	−0.0
	[2] 0.0001	0.0001	0.0000	0.0000	0.0001	0.0002
	[3] 10,906	3,936	10,906	10,906	6,864	3,555
SAT	[1] −.48	−0.41	0.30	0.08	1.00	0.05
	[2] 0.0001	0.0001	0.0001	0.0001	0.0000	0.0019
	[3] 7,083	3,902	6,984	6,864	7,093	3,627
IgG	[1] .07	0.75	0.21	−0.07	0.05	1.0
	[2] 0.0001	0.0001	0.0001	0.0002	0.0019	0.0000
	[3] 3,658	2,741	3,628	3,555	3,627	3,658

[1] Correlation coefficient.
[2] P value for testing the hypothesis that the population correlation coefficient is zero.
[3] Number of observations.

TABLE 8b.—CORRELATION COEFFICIENTS BETWEEN INITIAL VALUES OF WEIGHT AND SELECTED BIOCHEMICALS IN BLOOD OF CHILDREN

	Weight	C3	Hb	MCHC	SAT	IgG
Weight	[1] 1.00	0.01	0.07	0.12	0.11	0.13
	[2] 0.0000	0.2775	0.0001	0.0001	0.0001	0.0001
	[3] 16,280	5,415	15,877	15,410	10,888	4,727
C3	1.01	1.00	−0.05	−0.04	−0.24	0.23
	0.2775	0.0000	0.0064	0.0220	0.0001	0.0001
	5,415	5,415	5,346	5,268	5,156	3,589
Hb	1.07	−0.05	1.00	0.66	0.11	−0.06
	0.0001	0.0064	0.0000	0.0001	0.0001	0.0001
	15,877	5,346	15,877	15,410	10,719	4,683
MCHC	1.12	−0.04	0.66	1.00	0.11	−0.02
	0.0001	0.0020	0.0001	0.0000	0.0001	0.1295
	15,410	5,268	15,410	15,410	10,515	4,633
SAT	1.11	−0.24	0.11	0.11	1.00	−0.09
	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
	10,888	5,156	10,719	10,515	10,888	4,513
IgG	1.13	0.23	−0.06	−0.02	−0.09	1.00
	0.0001	0.0001	0.0001	0.1295	0.0001	0.0000
	4,727	3,589	4,683	4,633	4,513	4,727

[1] Correlation coefficient.
[2] P value for testing the hypothesis that the population correlation coefficient is zero.
[3] Number of observations.

Participation in the WIC program was associated with a fall in plasma concentration of complement 3 (table 9). The fall was evident in infants after 6 months in the program; it occurred more slowly in the children but was consistently observed by the time of the 11-month visit. The infants showed a fall in the plasma level of immunoglobulin G when they were examined after 6 months in the program while the children showed a progressive increase in the plasma level of this immunoglobulin (table 9). The changes in plasma concentration of C3 and IgG suggested that the program might have had an impact on infectious disease morbidity and on the body's defenses against infections. It is striking that the changes in plasma IgG level were in the same directions as the changes which occurred in the protein intakes of the participating infants and children.

TABLE 9.—THE EFFECT OF THE WIC PROGRAM ON PLASMA SPECIFIC PROTEINS OF INFANTS AND CHILDREN

Protein	Initial visit N	6-mo visit N	11-mo visit N	P_1[1]	mg/100 ml Δ_6[2]	P_{11}	mg/100 ml Δ_{11}
6 to 11 mo-old infants:							
C3	1,125	1,772		0.0001	−7		
IgA	929	1,620		.4890			
IgG	929	1,620		.0133	−27		
IgM	929	1,620		.2013			
1 to 5-yr-old children:							
C3	5,265	5,078	3,600	.1476		0.0001	−11
IgA	4,458	4,450	3,600	.0068	−3	.0001	−8
IgG	4,458	4,450	3,600	.0001	+27	.0001	+51
IgM	4,458	4,450	3,600	.0118	+4	.2589	

[1] P values after adjusting for age, sex, ethnic origin, and income poverty ratio.
[2] Δ_6 = differences between initial and stated revisits. + indicates increase at the time of visit as compared to initial value; − indicates a reduction.

The study indicated that elevated plasma level of C3 is associated with depression of the saturation of transferrin and with iron-related anemia which may not be due to a deficient dietary intake of iron (table 10). White infants and children in this study had lower plasma C3 values than black, Spanish-American and American Indian infants

and children (Volume II, Part 2, table 23). Plsama C3 concentration had an inverse relationship to income (Volume II, Part 2, table 24). There were no differences in iron intake by ethnic origin or income (Volume II, Part 2, table 19). A possible interaction between the immune system and iron transport which is exemplified by the association of plasma C3 with transferrin can explain the high anemia rate found in infants and childern from low income households and from ethnic minorities whose dietary iron intake is similar to that of other infants and children from more affluent backgrounds. Hence the findings of this study emphasize the need for improvement of the physical environment as well as the diet of the participants.

TABLE 10.—RESULTS OF MULTIPLE REGRESSION ANALYSIS TO SHOW THE RELATIONSHIP OF PLASMA LEVEL OF C3 TO INITIAL HEMOGLOBIN CONCENTRATION, ANEMIA RATE, PLASMA IRON, TRANSFERRIN, AND SATURATION OF TRANSFERRIN OF INFANTS AND CHILDREN

A. P VALUES

		P[1] values				
Variable	DF	Hemoglobin	Percent Hb<11g/100 ml	Iron	Transferrin	PSAT
C3 level	4	[2] 0.0017	0.0017	0.0001	0.0001	0.0001
Age group	1	.0001	.0001	.0001	.0005	.0001
Sex	2	.0815	.5781	.0077	.6271	.0009
Ethnic origin	5	.0001	.0001	.0001	.0001	.0001
Income poverty ratio	5	.0001	.0002	.0001	.0002	.0001

B. ADJUSTED MEANS

C3 level mg/100 ml	N	Hemoglobin g/100 ml	Percent Hb<11 g/100 ml	Iron μg/100 ml	Transferrin mg/100 ml	PSAT (percent)
Less than 50	68	11.9	12.6	74.3	279	24.1
51 to 100	1,981	11.9	17.8	78.1	346	19.2
101 to 150	3,232	11.8	19.5	74.0	394	16.0
151 to 200	822	11.7	24.2	66.3	421	12.8
More than 200	79	11.5	26.1	55.1	450	9.7

[1] P values after adjustments for all other factors in the regression model.
[2] C3 appears to affect hemoglobin directly and through saturation of transferrin. Whenever PSAT is included in the regressions as in table 6, the P values associating C3 with hemoglobin is increased.
[3] Includes a category of unknown.

Women

In the course of the evaluation a total of 9,867 women, including 4,125 with completed pregnancies, were investigated. After the initial examination, the women returned for 5,417 revisits at an estimated compliance rate of 40 percent. They were mostly young women with a mean age at enrollment of 23.1±5.7 years. They were 24.5 percent white, 38.6 percent black, 33.8 percent Spanish Americans and 2.5 percent others.

The initial diets of the pregnant women provided them with less energy, protein, calcium, iron, vitamin A, thiamine, riboflavin and niacin than is recommended for pregnant women (Table 11 and Figure 5). Participation in the WIC program increased their consumption of protein, calcium, phosphorus, iron, vitamin A, thiamine, riboflavin, niacin, ascorbic acid and folacin, but not of energy (Table 12).

TABLE 11.—INITIAL NUTRIENT INTAKES OF WOMEN ENROLLED IN THE WIC PROGRAM

Nutrient	Pregnant [1]						Postpartum N=179	
	Less than 12 weeks N=349		24 to 35 weeks N=985		36 plus weeks N=102			
Energy: kcals/day	[2]1,694.0	±777.0	1,722.0	±707.0	1,771.0	±684.0	1,653.0	±672.0
Protein: g/day	65.0	±30.0	66.0	±28.0	66.0	±29.0	64.0	±30.0
Calcium: mg/day	721.0	±483.0	724.0	±453.0	761.0	±512.0	752.0	±560.0
Phosphorus: mg/day	1,068.0	±496.0	1,050.0	±469.0	1,040.0	±511.0	1,014.0	±515.0
Iron: mg/day	10.0	±5.1	10.3	±5.0	10.8	±5.5	9.9	±5.4
Vitamin A: IU/day	3,706.0	±3,628.0	3,752.0	±3,348.0	4,059.0	±3,475.0	3,575.0	±3,200.0
Thiamine: mg/day	1.0	±.6	1.1	±.6	1.1	±.6	1.0	±.5
Riboflavin: mg/day	1.5	±.8	1.5	±.8	1.5	±.8	1.5	±.9
Niacin: mg/day	12.9	±7.6	13.4	±7.8	12.9	±7.0	12.9	±8.1
Ascorbic acid: mg/day	86.0	±89.0	94.0	±90.0	83.0	±79.0	68.0	±70.0

[1] These are representative examples. Duration of pregnancy affected only the intakes of calcium, phosphorus and riboflavin (vol. II, pt. 3, table 25).
[2] Results are mean value ±SD.

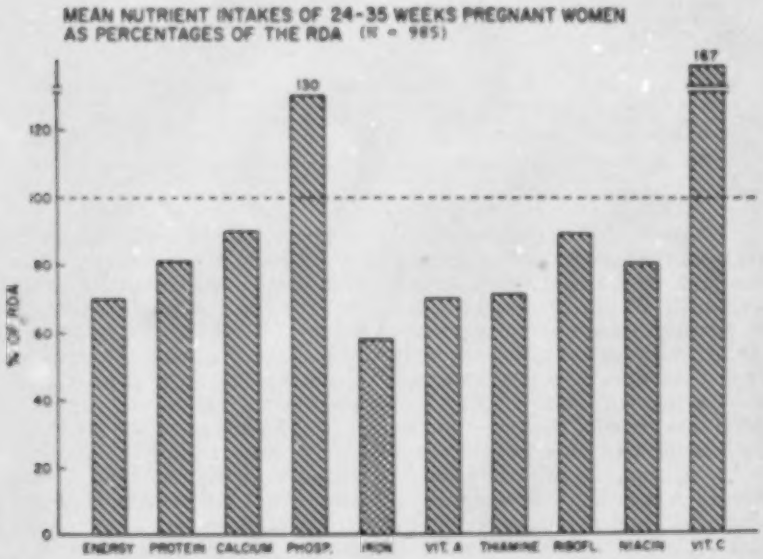


FIGURE 5

Postpartum women reported lower intakes of iron, vitamin A, thiamine, riboflavin, niacin and ascorbic acid than is recommended; when provided food supplements, they increased only their intakes of thiamine and ascorbic acid (Table 12).

TABLE 12.—RESULTS OF REGRESSION ANALYSES TO ESTIMATE THE IMPACT OF THE WIC PROGRAM ON N...TRIENT INTAKES OF PARTICIPANTS [1]

Nutrient	P<3 [2]	Δ<3 [3]	P3+ [2]	Δ3+ [3]
Pregnant women:				
Energy: kcals/day	0.2798	—	0.4751	—
Protein: g/day	.0057	+5.3	.0177	+4.6
Calcium: mg/day	.0001	+118	.0001	+123
Phosphorus: mg/day	.0005	+112	.0009	+107
Iron: mg/day	.0632	+.10	.0962	+.10
Vitamin A: IU/day	.0041	+650	.1335	+377
Thiamine: mg/day	.0022	+.12	.0081	+.10
Riboflavin: mg/day	.0001	+.30	.0001	+.22
Niacin: mg/day	.0142	+1.2	.1830	+.07
Ascorbic acid: mg/day	.0001	+26	.0043	+17
Folacin: μg/day	.0001	+29	.0004	+24
Postpartum women:				
Energy: kcals/day	.2233	—	.3158	—
Protein: g/day	.9078	—	.6478	—
Calcium: mg/day	.6921	—	.4295	—
Phosphorus: mg/day	.6426	—	.4873	—
Iron: mg/day	.5545	—	.4622	—
Vitamin A: IU/day	.9364	—	.4352	—
Thiamine: mg/day	.2260	+.08	.0098	+.15
Riboflavin: mg/day	.7635	—	.7347	—
Niacin: mg/day	.3385	—	.6508	—
Ascorbic acid: mg/day	.0732	+18	.0017	+28
Folacin: μg/day	.7019	—	.1845	—

[1] The data set contained, for pregnant women: initial visit 2,754, <3 month's visit 266, and 3+ month's visit 290—dietary records and for post partum women: initial visit 179, <3 month's visit 182, and 3+ month's visit, 421 dietary records.

[2] P values after adjustir g for pregnancy/post partum duration, age, ethnic origin, income poverty ratio and project location.

[3] Δ's=differences between initial and stated visits, (+) indicates increase at the time of visit as compared to initial mean value; (—) indicates a reduction. The mean values were adjusted for pregnancy/post partum duration, age, ethnic origin, income poverty ratio and project location.

Measurement of plasma levels of vitamin A, folacin and vitamin C indicated that the intakes of vitamin A and folacin in particular, and of vitamin C to a lesser degree, were insufficient to meet metabolic needs (Table 13). About 25 percent of the pregnant women and 7 percent of the postpartum women had plasma vitamin A levels less than 20 μg/100 ml. With regard to folacin, about 25 percent of the women were in the low or unsatisfactory category (plasma values <6 ng/ml) and about 4 percent were actually deficient (plasma values <3 ng/ml). About 3 percent of the pregnant women and 5 percent of the postpartum women had unsatisfactory values for plasma vitamin C (plasma level <0.2 mg/100 ml). The data suggested that the requirement for vitamin A was high throughout pregnancy, that the requirement for folacin was higher during the first and second trimesters of pregnancy than during the third trimester of pregnancy and the postpartum period while the greatest requirement for vitamin C was during the third trimester of pregnancy and the lactation period (Figure 6). The WIC program was associated with a reduction in the occurrence of unsatisfactory plasma vitamin A values in women pregnant for more than 28 weeks and a reduction in the occurrence of unsatisfactory plasma vitamin C values in women pregnant for more than 28 weeks and in postpartum women (Table 13).

TABLE 11.—RESULTS OF MULTIPLE REGRESSION ANALYSIS TO SHOW THE EFFECT OF THE WIC PROGRAM ON THE PREVALENCE OF UNSATISFACTORY VALUES FOR PLASMA VITAMIN LEVELS

Variable	Initial visit N	Less than 3 mo visit N	3 plus mo visit N	Initial, percent unsatisfactory	P less than 3 mo [1]	Δ less than 3 mo [2]	P 3 plus mo [1]	Δ 3 plus mo [2]
Less than 17 weeks pregnant:								
Vitamin A <20 μg/100 ml	1,088	.....	.....	21.4	.....	.....	.....	.....
Carotene <80 μg/100 ml	1,901	.....	.....	26.4	.....	.....	.....	.....
Vitamin C <0.2 mg/100 ml	1,387	.....	.....	2.8	.....	.....	.....	.....
Folacin <3 ng/ml	439	.....	.....	4.7	.....	.....	.....	.....
17 to 28 weeks pregnant:								
Vitamin A <20 μg/100 ml	438	204	230	22.9	0.3927	.....	0.4058	.....
Carotene <80 μg/100 ml	2,439	385	230	24.1	.9719	.....	.4958	.....
Vitamin C <0.2 mg/100 ml	1,605	136	134	4.1	.0644	.....	.1652	.....
Folacin <3 ng/ml	383	58	58	5.9	.3832	.....	.3890	.....
More than 28 weeks pregnant:								
Vitamin A <20 μg/100 ml	1,313	311	630	31.5	.0460	−4.9	.0007	−6.6
Carotene <80 μg/100 ml	1,912	313	640	24.9	.6744	.....	.4112	.....
Vitamin C <0.2 mg/100 ml	983	176	348	6.3	.0355	−3.0	.0064	−3.8
Folacin <3 ng/ml	267	72	146	5.9	.8289	.....	.8487	.....
Postpartum women:								
Vitamin A <20 μg/100 ml	425	427	1,102	5.9	.0405	.....	.0005	.....
Carotene <80 μg/100 ml	434	435	1,133	4.9	.2948	.....	.4298	.....
Vitamin C <0.2 mg/100 ml	345	270	589	5.2	.0803	−4.5	.0001	−6.6
Folacin <3 ng/ml	91	98	267	5.5	.7776	.....	.8406	.....

[1] P values for stated visit after adjustments for age, ethnic origin, income poverty ratio and pregnancy/postpartum duration.

[2] Δ's = differences between initial and stated revisit, + indicates increase at the time of visit as compared to initial value; − indicates a reduction. The mean values were adjusted for age, ethnic origin, income poverty ratio and pregnancy/postpartum duration.

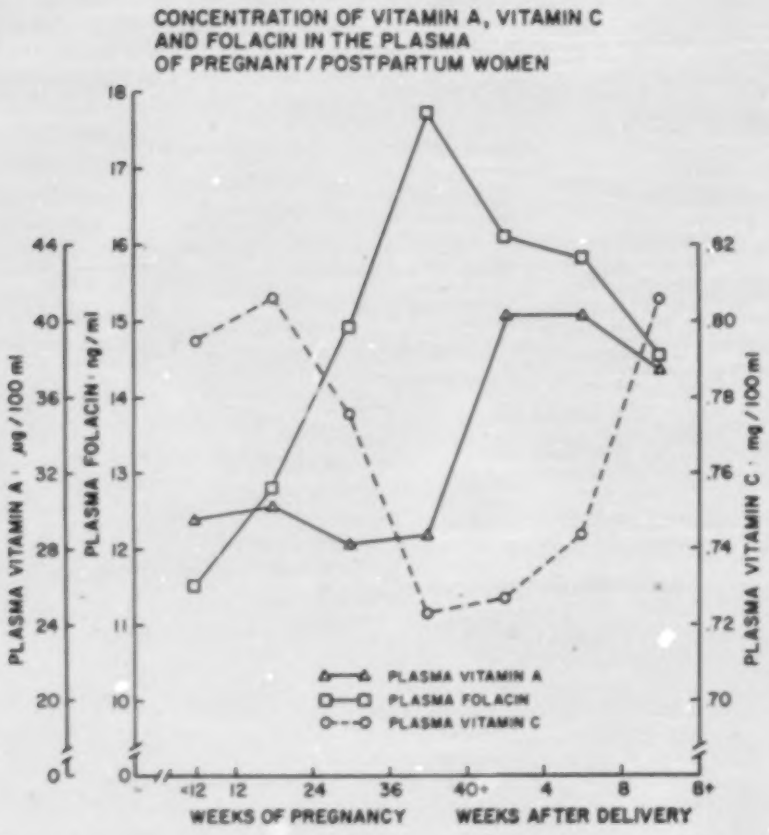


FIGURE 6.—The number of participants in order of <12, 12–23, 24–35, 36–39 weeks pregnant and <4, 4–7 and 8+ weeks postpartum were respectively: 700, 2793, 1883, 284, 128, 128 and 169 for vitamin A; 517, 1866, 1371, 166, 111, 105 and 149 for vitamin C; 171, 641, 449, 39, 28, 25 and 38 for folacin. Results are initial values only. Multiple regression analyses showed that, after adjustments for age, ethnic origin and income poverty ratio, the differences by pregnancy/postpartum duration were statistically significant ($p < .05$) for all three vitamins.

Initially, the women gained an average of 10.5 kg (23 lbs.) during pregnancy. During the second and third trimesters they gained weight at the rate of 0.35 kg/week. These initial values were slightly less than the 11.0–12.5 kg total weight gain and 0.4 kg/week rate of gain which are considered to be ideal. Women who received WIC foods gained about 2 kg (4.4 lbs.) more weight at 24–27 and at 28–31 weeks of pregnancy (Figure 7). The differences between supplemented

women and those from the initial population were not statistically significant at the other three time periods at which measurements were made (20–23, 32–35, 36–39 weeks) but in every case there was a consistent trend towards greater weight gain by participants in the WIC program (Figure 8). When all pregnancy duration groups were pooled the data indicated that participants in the WIC program had gained more weight than women in the initial population (Figure 7).

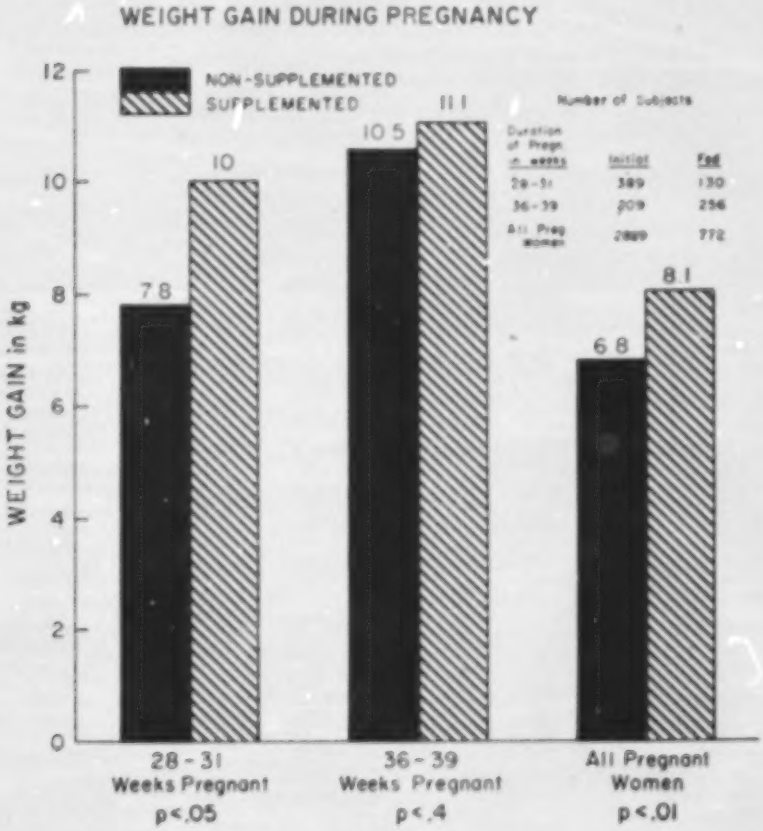
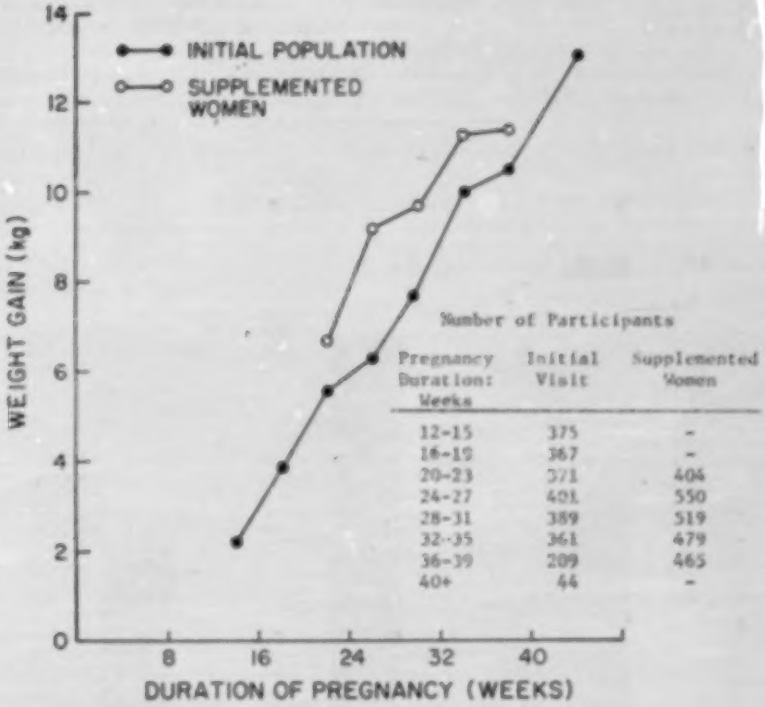


FIGURE 7.—Initial mean ±S.E. values were 7.78±0.32 kg, 10.46±0.43 kg and 6.84±0.14 kg respectively for 28–31 weeks pregnant, 36–39 weeks pregnant and postpartum women. Result for fed women in each case was the initial value ± observed change adjusted for ethnic origin, smoking, pregnancy order, income poverty ratio, age, pregnancy duration, prepregnant weight and height.



Number of Participants

Pregnancy Duration: Weeks	Initial Visit	Supplemented Women
12-15	375	-
16-19	367	-
20-23	371	404
24-27	401	550
28-31	389	519
32-35	361	479
36-39	209	465
40+	44	-

FIGURE 8

The mean birth weight of babies in the study population was 3,283 g for boys and 3,162 g for girls. The average birth weight (both sexes) of 3,225 g was about 125 g less than the standard (*1*). Black babies had a significantly lower birth weight than babies of the other ethnic groups. The WIC program was associated with an increase in the mean birth weight of babies (table 14). There was also a fall in the low birth weight rate of black babies (Volume II, Part 3, table 20). Supplementation for a period of less than three months had no effect. The impact of the program was greater on black and Spanish American babies than on white babies. Part of the program effect could be accounted for by an increase of about five days in the gestational duration while a smaller proportion appeared to be a direct one on fetal growth (Volume II, Part 3, tables 16 and 17).

TABLE 14.—RESULTS OF REGRESSION ANALYSIS TO SORT OUT THE SIGNIFICANCE OF FACTORS WHICH INFLUENCE BIRTH WEIGHT AND TO MEASURE THE IMPACT OF THE WIC PROGRAM ON BIRTH WEIGHT

1. P VALUES

Independent variable	DF	P values [1] model 1 with weight and height	Model 2 with weight for height index
Ethnic origin	3	0.0001	0.0001
Sex	1	.0003	.0002
Income-poverty ratio	5	.1046	.2965
Pregnancy order	5	.0057	.0060
Prepregnant weight	1	.0001	----------
Height	1	.0001	----------
Weight for height index	5	----------	.0001
Smoking	3	.0001	.0001
WIC program	3	.0234	.0220

2. ADJUSTED MEAN BIRTH WEIGHTS

Duration of participation	Adjusted means,[2] model 1	Model 2
0	[3] 3,057 (41)	3,120 (41)
Less than 3 mo	3,052 (421)	3,094 (421)
3 to 6 mo	3,125 (412)	3,165 (412)
More than 6 mo	3,193 (139)	3,222 (139)

[1] P values after adjusting for all other variables in the regression analysis.
[2] Means adjusted for all factors other than WIC program.
[3] Figures in parentheses are numbers of babies.

After considering possible alternative explanations, it was thought that the increase in weight gain during pregnancy as well as the increase in birth weight were due to the improved diet of the women.

About 13 percent, 29 percent and 27 percent, respectively, of women in their first, second, and third trimesters of pregnancy had blood hemoglobin levels less than 11.0 g per 100 ml while 23.3 percent of postpartum women had hemoglobin concentration less than 12.0 g/100 ml (Figure 9). The WIC program reduced the prevalence of anemia among women who were in the third trimester of their pregnancy and in postpartum women but not the others (Table 15 and Figure 9). The selective pattern of effect on pregnant women suggested that 11 g/100 ml may be too high a level of hemoglobin for the diagnosis of nutritional anemia in the first and second trimesters of pregnancy.

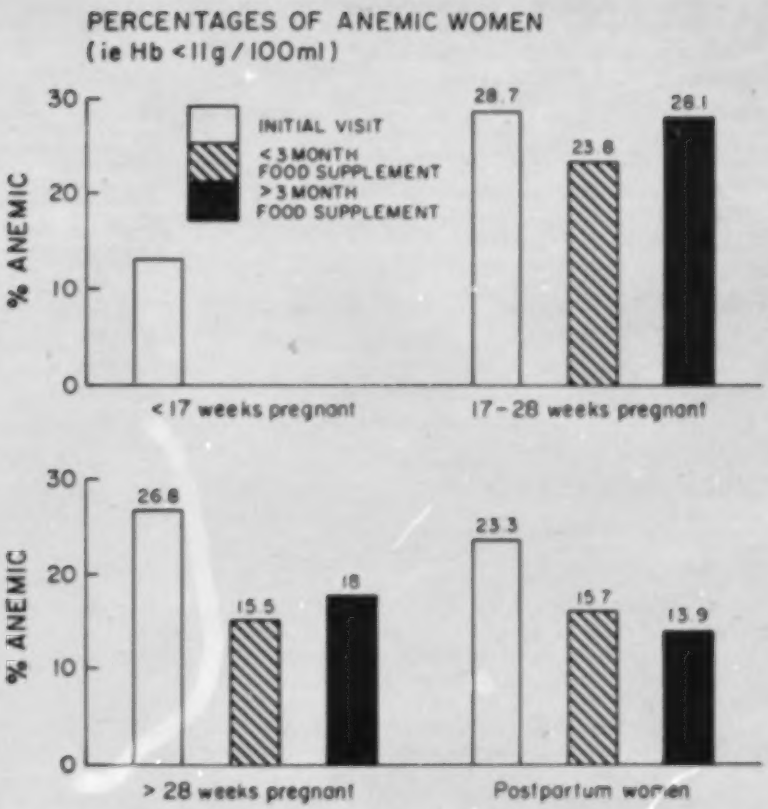


Figure 9.—Number of participants:
< 17 weeks: Initial 1984.
17-28 weeks: Initial 2750, < 3 months 324, 3+ months 229.
> 28 weeks: Initial 1379, < 3 months 346, 3+ months 646.
Postpartum: Initial 462, < 3 months 441, 3+ months 1191.
The difference between initial value and each of the follow-up values is statistically significant ($p < .05$) for women > 28 weeks pregnant and for postpartum women.

TABLE 15.—EFFECT OF THE WIC PROGRAM ON THE PREVALENCE OF ANEMIA AND OF UNSATISFACTORY INDICES OF IRON NUTRITURE

Variable	Initial visit N	<3 mo visit N	>3 mo visit N	Initial percent unsatisfactory	P<3[1] mo	Δ<3[2] mo	P 3+[1] mo	Δ3+[2] mo
Less than 17 weeks pregnant:								
Hemoglobin, <11 g/100 ml	1,984	0	0	13.4				
Hematocrit, <33 percent	1,984	0	0	9.3				
MCHC, <30 percent	1,984	0	0	8.2				
Total iron, <40 μg/100 ml	1,748	0	0	2.1				
Transferrin, <400 mg/100 ml	1,748	0	0	16.4				
PSAT, <15 percent	1,748	0	0	12.9				
17 to 28 weeks pregnant:								
Hemoglobin, <11 g/100 ml	2,570	324	229	28.7	0.0525		0.8564	
Hematocrit, <33 percent	2,570	324	229	21.6	.9481		.6635	
MCHC, <30 percent	2,570	324	229	8.9	.0793	−3.7	.0512	
Total iron, <40 μg/100 ml	2,251	277	197	3.5	.5546		.1570	
Transferrin, <400 mg/100 ml	2,251	277	197	44.3	.6610		.7315	
PSAT, <15 percent	2,251	277	197	29.7	.0569		.1707	
More than 28 weeks pregnant:								
Hemoglobin, <11 g/100 ml	1,379	346	646	25.8	.0081	−11.2	.2881	−8.7
Hematocrit, <33 percent	1,379	346	646	14.8	.0279	−8.9	.0171	−6.6
MCHC, <30 percent	1,379	346	646	10.6	.0031	−6.5	.0051	−6.8
Total iron, <40 μg/100 ml	1,228	281	569	4.1	.5450		.0668	
Transferrin, <400 mg/100 ml	1,278	281	569	64.5	.3448		.0428	−6.1
PSAT, <15 percent	1,228	281	569	36.5	.3733		.2731	
Postpartum women:								
Hemoglobin, <12 g/100 ml	462	441	1,191	7.5	.0037	−7.6	.0001	−9.7
Hematocrit, <36 percent	462	441	1,191		.5990		.4016	
MCHC, <30 percent	462	441	1,191	13.2	.0013	−6.5	.0005	−5.6
Total iron, <40 μg/100 ml	396	352	1,084	3.2	.0191	+4.7	.0038	+5.6
Transferrin, <400 mg/100 ml	396	352	1,084	16.0	.0099	+7.8	.1733	
PSAT, <15 percent	396	352	1,084	21.7	.1025		.0007	+9.7

[1] P values for stated visit after adjustments for age, ethnic origin, income poverty and pregnancy/postpartum duration.
[2] Δ's equal differences between initial and stated revisit. + indicates increase at the time of visit as compared to initial value; − indicates a reduction.

The indices of iron nutrition gave conflicting estimates of iron deficiency. Use of saturation of transferrin value below 15 percent gave the highest estimates followed by use of MCHC value less than 30 g/100 ml and then use of a plasma iron cut-off value of 40 μg/100 ml. For instance, the estimates provided by saturation of transferrin value below 15 percent, MCHC value less than 30 g/100 ml and plasma iron value less than 40 μg/100 ml were respectively, 36.5 percent, 10.6 percent, and 4.1 percent for women more than 28 weeks pregnant and 21.7 percent, 13.2 percent and 3.2 percent for postpartum women (Table 15). Hence the use of two different indices could provide estimates with as much as a nine-fold difference.

The nature of the association between plasma C3 and iron transport is still not known. It is possible that transferrin itself is an acute phase reactant like C3 and C-reactive protein and hence its concentration in plasma may be influenced by the same pathophysiologic mechanisms which alter plasma C3 level in acute inflammations, chronic diseases and malnutrition. But whatever is the nature of the relationship between C3 and transferrin, its medical importance is evident. It accounts for some of the iron-related anemia found in infants and children both directly and through its effect on saturation of transferrin. In pregnant women it could influence hemoglobin concentration through its effect on saturation of transferrin. It may also be related to the low plasma iron, the subnormal saturation of transferrin and the anemia of chronic disorders although the TIBC is characteristically reduced in these disorders.

Regarding the impact of the WIC program, there was a decrease in the occurrence of unsatisfactory MCHC results in 17–28 weeks pregnant women fed for less than 3 months, in women pregnant for longer than 28 weeks and in postpartum women. The program did not alter the prevalence of unsatisfactory plasma iron and saturation of transferrin values in pregnant women but more participating postpartum women had unsatisfactory values than women in the initial population (Table 15). Hence the increase in mean hemoglobin concentration (Table 16) and the reduction in the prevalence of anemia (Table 15) which occurred in women pregnant for 28 weeks or longer and in postpartum women were paralleled by changes in MCHC but not by changes in saturation of transferrin values.

TABLE 16.—CHANGES IN MEAN HEMATOLOGICAL VALUES ASSOCIATED WITH PARTICIPATION IN THE WIC PROGRAM

Variable	Initial visit N	<3 mo visit N	>3 mo visit N	Initial value[1]	P<3[2] mo	Δ<3[3] mo	P3+[2] mo	Δ3+[3] mo
Less than 17 weeks pregnant:								
Hemoglobin, g/100 ml	1,784	0	0	12.3±1.2				
Hematocrit, percent	1,784	0	0	37.0±3.1				
MCHC, g/100 ml	1,764	0	0	33.2±2.2				
Total iron, μg/100 ml	1,748	0	0	167.0±46.0				
Transferrin, mg/100 ml	1,748	0	0	329.0±74.0				
PSAT, percent	1,748	0	0	27.7±12.6				
17 to 28 weeks pregnant:								
Hemoglobin, g/100 ml	2,570	324	229	11.[illegible]	1.3	0.[illegible]	.0003	0.9866
Hematocrit, percent	2,570	324	229	37.0±[illegible]	[illegible]	[illegible]	.6309	.9500
MCHC, g/100 ml	2,570	324	229	33.2±2.4	.1307		.9887	
Total iron, μg/100 ml	2,251	277	197	102.0±46.0	.2192		.6130	
Transferrin, mg/100 ml	2,251	277	197	294.0±91.0	.3625		.9568	
PSAT, percent	2,251	277	197	22.2±11.7	.1162		.3991	
More than 28 weeks pregnant:								
Hemoglobin, g/100 ml	1,379	346	606	11.7±2.5	.0001	+0.33	.0001	+0.33
Hematocrit, percent	1,379	346	606	35.2±3.6	.0134	+.47	.0021	+.51
MCHC, g/100 ml	1,379	346	606	33.1±2.4	.0006	+.48	.0062	+.42
Total iron, μg/100 ml	1,220	291	569	109.0±57.0	.8278		.7082	
Transferrin, mg/100 ml	1,220	291	569	439.0±93.0	.6139		.0486	−9.9
PSAT, percent	1,220	291	569	20.4±12.2	.6478		.5831	
All pregnant women:								
Hemoglobin, g/100 ml	5,933	676	875	11.9±1.7	.0001	+.21	.0001	+.28
Hematocrit, percent	5,933	676	875	35.7±3.6	.0703		.0272	+.29
MCHC, g/100 ml	5,933	676	875	33.2±2.4	.0008	+.33	.0026	+.27
Total iron, μg/100 ml	5,227	564	766	104.0±47.0	.5284		.5691	
Transferrin, mg/100 ml	5,227	564	766	383.0±97.0	.3181		.1795	
PSAT, percent	5,227	564	766	23.6 12.6	.2705		.0423	
Postpartum women:								
Hemoglobin, g/100 ml	462	441	1,191	11.0±1.6	.0019	+.31	.0001	+.33
Hematocrit, percent	462	441	1,191	33.5±4.1	.8419		.0671	
MCHC, g/100 ml	462	441	1,191	32.7±2.5	.0001	+.62	.0001	+.54
Total iron, μg/100 ml	396	392	1,084	95.0±39.0	.1778		.0145	−6.5
Transferrin, mg/100 ml	396	392	1,084	331.0±69.0	.0052	+17.0	.0085	
PSAT, percent	396	392	1,084	25.6±14.6	.0005	−3.8	.0001	−4.2

[1] Mean values ± SD.
[2] P values for stated visit after adjustments for age, ethnic origin, income poverty ratio and pregnancy duration.
[3] Δ's equal differences between initial and stated revisit. + indicates increase at the time of visit as compared to initial value; − indicates a reduction.

It was not possible to identify any single factor which could account for the increase in the hemoglobin level of women participants. The data indicated that the iron in the WIC food package was probably not a major factor. It would appear that the favorable impact of the program in reducing the incidence of anemia was due to a combination of several factors, including the additional supply of a variety of nutrients, one or more of which might have been available in insufficient amounts in the initial diets of some of the participants and limited their synthesis of hemoglobin and/or their production of red blood corpuscles.

PUBLIC HEALTH SIGNIFICANCE

The medical benefits of the WIC program have been described in terms of measurable changes in anthropometric, dietary and biochemical indices as required by the contract with FNS. It should be pointed out, however, that the underlying assumption that these benefits represent improvements to the health and well-being of the participants may or may not be true. It would be impossible, for instance, to state with any degree of assurance whether or not an increase of 0.4 g/100 ml in hemoglobin concentration improved the health of a given individual. The answer depends on several factors such as the initial level of hemoglobin and the physiological level appropriate for that individual.

While it is difficult to assess the significance of the changes to the health of individuals, most experts will agree that, for the population as a whole, it is desirable for the average to approximate, as far as possible, to the established "norm" or "standard." Deviations from such standards provide justification for corrective programs; and the extent of the deviation from the standard should determine the magnitude of the corrective effort. Hence, in this study, every effort was made to define as clearly and as fully as possible, the initial baseline values of each measurement for the total study population and for subgroups of interest and to compare these baseline values to available standards. The observed changes are considered "real" health benefits to the participants to the extent to which they tend to bring them closer to the accepted norms.

The present evaluation was concerned with the short-term benefits of the WIC program. The long-term effects on growth, development, morbidity, mortality, behavior and learning are still unknown and should be investigated.

Income was the most commonly used guideline for selection of participants. In this connection it is pertinent that for several indices measured in this study, the dividing line between "high" risk and "low" risk groups was not at an income poverty ratio of 1.0 but at a ratio of about 1.5 (Volume II, pages 104, 163, 165, 228).

An alternative to income as a basis for eligibility is to identify individuals with the lowest values for selected nutritional indices. Unfortunately, efforts to determine the differential impact of the program according to initial individual results were not very productive. The increase in the blood hemoglobin concentration of infants and children occurred in the first 6 months of program participation (Figure 4) and was directly related to the initial level of hemoglobin i.e., those who had the highest initial hemoglobin level increased the most (Table 17). The result was that the entire hemoglobin distribution was shifted to a higher median value (Tables 18 and 19). Black infants and children were taller, on the average, than white infants

and children (Figure 10 and Appendix 1*), yet the impact of the program on height was greater for the black ethnic group than for the white ethnic group (Table 20). Finally, it was not possible to identify individuals with low nutrient intakes since the 24-hour recall method does not provide reliable data for the usual daily nutrient intakes of individuals.

TABLE 17.—RESULTS OF REGRESSION ANALYSES TO SHOW THE RELATIONSHIP OF CHANGE IN BLOOD HEMOGLOBIN CONCENTRATION ASSOCIATED WITH THE WIC PROGRAM TO THE INITIAL HEMOGLOBIN LEVEL

A. ANALYSIS

Independent variables	DF	P_1 [1]	P_{II} [1]
Initial Hb level	2	0.0006	0.6230
Initial Hb concentration: g/100 ml [2]	1	.0001	.0001
Age group	9	.0001	.0001
Sex (boy, girl, unknown)	2	.7124	.3124
Ethnic origin	5	.0001	.0030
Income poverty ratio	5	.2873	.3384

B. ADJUSTED MEAN VALUES FOR CHANGE IN HEMOGLOBIN CONCENTRATION (Δ)

Hemoglobin level	Δ_I [3,4]	Δ_{II} [3,4]
Less than 11	−0.09 (2,404)	0.23 (518)
11 to 13	.05 (4,355)	.21 (968)
13 plus	.18 (1,219)	.39 (254)

[1] P values after adjustments for all other factors in the regression.
[2] The initial hemoglobin concentration (as a continuous variable) was included as an independent variable in order to correct for the correlation between the change in hemoglobin concentration and the initial hemoglobin concentration.
[3] Difference between stated and initial visits in mean concentrations of hemoglobin adjusted for initial hemoglobin concentration, age, sex, ethnic origin, and income poverty ratio.
[4] Numbers in parenthesis are numbers of participants.

TABLE 18.—CUMULATIVE PERCENTAGE DISTRIBUTIONS OF HEMOGLOBIN VALUES IN 6- TO 11-MONTH-OLD INFANTS AT INITIAL, 6-MONTH, AND 11-MONTH VISITS

Hemoglobin, g/100 ml	Initial visit (percent)			6-month visit (percent)			11-month visit (percent)		
	N	Frequency	Cumulative frequency	N	Frequency	Cumulative frequency	N	Frequency	Cumulative frequency
Less than 7	8	0.2	0.2	2	0.1	0.1	1	0.3	0.3
7 to 7.9	33	1.0	1.2	6	.2	.3	1	.3	.6
8 to 8.9	86	2.5	3.7	20	.7	1.0	1	.3	.9
9 to 9.9	257	7.4	11.1	86	3.2	4.2	12	3.9	4.8
10 to 10.4	207	6.9	20.0	127	4.6	8.9	16	5.1	9.9
10.5 to 10.7	378	10.9	30.8	259	7.6	16.4	54	10.9	20.8
11 to 11.9	1,159	33.5	64.3	1,005	35.7	52.1	103	33.1	53.9
12 to 12.9	866	25.0	89.3	919	33.6	85.7	100	32.2	86.1
13 to 13.9	275	8.0	97.3	245	10.4	97.1	38	12.2	98.3
14 to 14.9	61	1.8	99.1	55	2.0	99.1	2	.6	98.9
15 to 15.9	16	.5	99.6	14	.5	99.6	1	.3	99.2
16+	16	.5	100.0	8	.4	100.0	2	.6	100.0
Total	3,458	100.0	.....	2,738	.....	.....	311	.....	.....

Initial visit (N = 3,458), g/100 ml:	
Mean ± SD	11.5 ± 1.4
Mode ± SD	11.4
Median ± SD	11.5
6-month visit (N = 2,738), g/100 ml:	
Mean ± SD	11.9 ± 1.2
Mode ± SD	12.0
Median ± SD	11.9

*See p. 39.

TABLE 19.—CUMULATIVE PERCENTAGE DISTRIBUTION OF HEMOGLOBIN VALUES IN 1- TO 3-YEAR-OLD CHILDREN AT INITIAL, 6-MONTH AND 11-MONTH VISITS

Hemoglobin, g/100 ml	Initial visit (percent)			6-month visit (percent)			11-month visit (percent)		
	N	Frequency	Cumulative frequency	N	Frequency	Cumulative frequency	N	Frequency	Cumulative frequency
Less than 7	40	0.3	0.3	7	0.1	0.1	4	0.1	0.1
7 to 7.9	127	.8	1.1	38	.5	.6	10	.2	.3
8 to 8.9	354	2.3	3.4	79	1.0	1.6	41	.8	1.1
9 to 9.9	811	5.3	8.7	208	2.7	4.3	95	1.9	3.0
10.1 to 10.4	1,017	6.6	15.3	288	3.8	8.1	175	3.6	6.6
10.5 to 10.9	1,321	8.6	23.9	393	5.2	13.3	268	5.5	12.1
11 to 11.9	4,845	31.6	55.5	2,189	28.8	41.2	1,366	28.0	40.1
12 to 12.9	4,668	30.4	85.9	2,830	37.2	78.3	1,647	37.9	78.0
13 to 13.9	1,731	11.3	97.2	1,276	16.8	95.1	845	17.3	95.3
14 to 14.9	310	2.0	99.2	338	3.1	98.1	184	3.9	99.1
15 to 15.9	61	.4	99.6	35	.5	98.6	29	.6	99.7
16+	65	.4	100.0	21	.3	100.0	9	.2	100.0
Total	15,350	100.0		7,603			4,873		

Initial visit (N=15,350), g/100 ml:
- Mean±SD: 11.7±1.4
- Mode±SD: 12.0
- Median±SD: 11.8

6-month visit (N=7,603), g/100 ml:
- Mean±SD: 12.1±1.2
- Mode±SD: 12.0
- Median±SD: 12.1

11-month visit (4,873), g/100 ml:
- Mean±SD: 12.1±1.2
- Mode±SD: 12.1
- Median±SD: 12.2

TABLE 20.—COMPARISONS OF INCREASES IN WEIGHT, HEIGHT, AND HEAD CIRCUMFERENCE OBSERVED AFTER 6 AND 11 MOS. OF PROGRAM PARTICIPATION WITH CORRESPONDING INCREMENTS EXPECTED FROM THE INITIAL DATA

Variable ethnic origin/sex	6-mo visit			11-mo visit		
	N	$\Delta_{o1}-\Delta_{e1}$[1]	P[2]	N	$\Delta_{o2}-\Delta_{e2}$[3]	P[2]
Weight, kilograms:						
White male	1,156	+0.23	✓	810	+0.06	×
White female	1,092	+.24	✓	477	+.06	✓
Black male	1,350	+.23	✓	534	+.14	✓
Black female	1,264	+.26	✓	541	+.23	✓
Spanish-American male	2,389	+.21	✓	1,595	+.10	✓
Spanish-American female	2,292	+.13	✓	1,564	+.04	×
Entire population	9,543	+.23	✓	5,217	+.21	✓
Height, centimeters:						
White male	1,006	+.24	×[4]	446	−.23	×
White female	964	+.49	✓[4]	422	+.70	✓[4]
Black male	1,162	+.60	✓[4]	493	−.09	✓[4]
Black female	1,067	+.61	✓[4]	476	+1.1	✓[4]
Spanish-American male	2,248	+.60	✓	1,512	+.51	✓
Spanish-American female	2,443	+.34	✓	1,487	+.61	✓
Entire population	8,630	+.48	✓	4,914	+.30	✓
Head circumference, centimeters:						
White male	1,111	+.02	×	497	−.15	×
White female	1,058	+.03	×	472	−.13	×
Black male	1,195	+.07	×	549	−.05	×
Black female	1,132	−.02	×	558	−.09	×
Spanish-American male	2,366	+.05	×	1,581	−.02	×
Spanish-American female	2,281	+.08	✓	1,553	−.02	×
Entire population	9,143	+0.4	×	5,210	+.04	×

[1] Δ_{o1}: Observed increase at the time of the 6-mo followup.
[2] Δ_{e1}: Expected increase by the time of the 6-mo followup.
[3] ✓: Statistically significant at the 0.05 level; not statistically significant at the 0.05 level.
[4] Δ_{o2}: Observed increase at the time of the 11-mo followup.
[5] Δ_{e2}: Expected increase at the time of the 11-mo followup.
[6] The differences in gain in height ($\Delta_o-\Delta_e$) between white boys and black boys and between white girls and black girls were statistically significant ($p<0.05$).

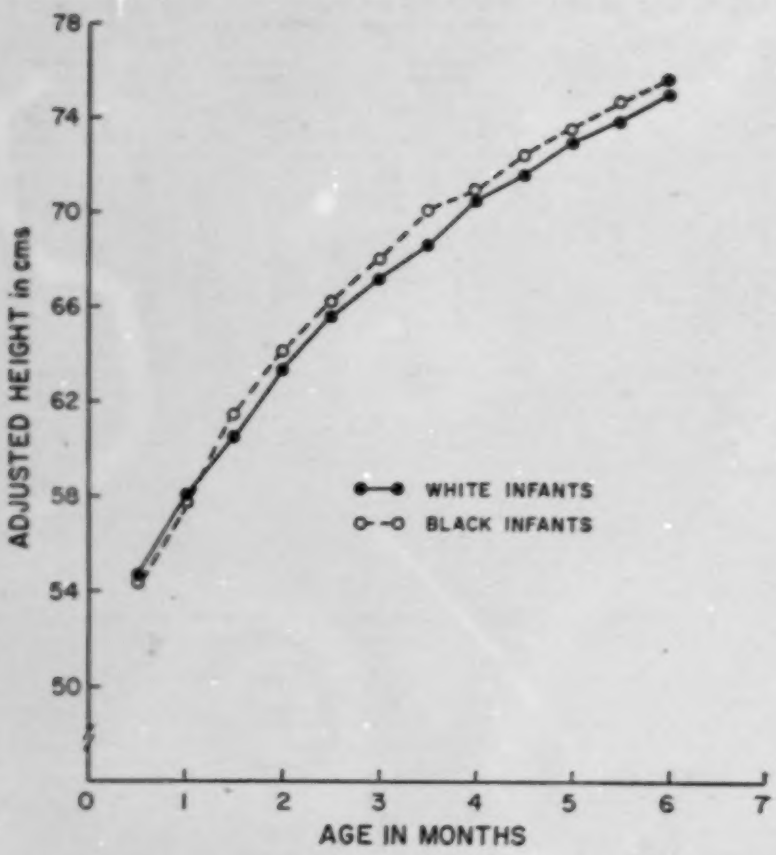


FIGURE 10.—Comparison of height for age of black and white infants. The height measurements were adjusted for age, sex and income poverty ratio. Data were obtained from 1850 white infants and 2873 black infants.

To sum up, the measurable effects of the WIC program are considered "real" health benefits to the participants because the initial values for several of the indices investigated were below the accepted standards and the program moved them closer to the standards. The long-term benefits of the WIC program should be investigated. Income poverty ratio provided a satisfactory guideline for eligibility. The study did not provide medical justification for exclusion of potentially eligible participants on the basis of their initial measurements.

CONCLUSIONS

A. Infants and Children

1. The WIC program was associated with an acceleration of growth in weight and height. An increase in head circumference occurred in infants enrolled within one month of birth.

2. There was a consistent increase in the mean blood hemoglobin concentration of participants in the program and a reduction in the prevalence of anemia. The main effect occurred during the first six months of participation.

B. Women

1. Pregnant women who participated in the WIC program gained more weight during pregnancy than women in the initial population. The maximum difference of about 2 kg (4 lbs., 6 oz.) occurred in women who were pregnant for 24–31 weeks.

2. The WIC program was associated with an increase in the mean birth weight of babies. The impact of the program was greater on black and Spanish American babies than on white babies.

3. There was an increase in mean hemoglobin concentration and a reduction in the anemia rate in women who were pregnant for more than 28 weeks and in postpartum women.

RECOMMENDATIONS FOR FURTHER STUDY

1. The growth impact on infants and children was examined in 6 month age groups from 6–47 months. The smallest increase was in 6–11 months old infants. It is possible that infants of this age group had already achieved almost their maximum growth potential and hence their growth rate could not be accelerated much further. On the other hand, the findings of the study raised some question about the nutrient and especially the protein content of infant formula particularly when it is used as the major food for older infants. This matter deserves further study.

Additionally, the finding of an acceleration of growth in children who were already consuming adequate amounts of all nutrients which were investigated, with the exception of iron, raised questions about the criteria for adequacy of the recommendations. In this connection, it is pertinent that an informal group of experts has recommended a reassessment of the protein requirement of adults (*3*) in the light of recent observations that the RDA for protein may be insufficient for long-term maintenance of health in young adults (*4, 5*).

2. The issue of iron deficiency is important. On the one hand, the initial dietary iron intake of the participants was less than the RDA and anemia was highly prevalent. On the other hand, the dietary iron supplements provided by the WIC program appeared to have played an uncertain role in the reduction in anemia prevalence. There is, therefore, an urgent need to explore alternative explanations for the anemia. For example, this study indicated that there is an interaction between complement 3 and iron transport.

3. The availability of the iron in the supplements deserve further study.

4. The effect of the WIC program on plasma ferritin concentration should be investigated.

5. The effect of the WIC program on children who are still receiving food supplements and have been in the program for two or more years should be studied.

6. The nutritional status, health and achievement level of 5- to 7-year-old children who had received food supplements in the WIC program for at least 1 year should also be investigated.

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(31)

GLOSSARY OF TERMS

1. Abbreviations:
   - CDC—Center for Disease Control, Atlanta, Georgia.
   - FNS—Food and Nutrition Service of the United States Department of Agriculture.
   - *GAO—General Accounting Office.*
   - RDA—Recommended Dietary Allowances.
   - RFP—Request for Proposal.
   - RTI—Research Triangle Institute, Research Triangle Park, North Carolina 27709.
   - S.D.—Standard Deviation.
   - S.E.—Standard Error.
   - UNC—University of North Carolina at Chapel Hill, Chapel Hill North Carolina 27514.
   - USDA—United States Department of Agriculture.
   - WIC—Special Supplemental Food Program for Women, Infants and Children.

2. *Adjusted Mean.*—Average value of a series of measurements for a group after adjusting for all other variables which have been considered. Difference between adjusted means is used to show real differences between groups.

3. *Age.*—When age is given in years, it means the age of the individuals on his/her last birthday; thus a 3-year-old child is one who is 3 or more years of age but less than 4 years of age. The age in months is the number of completed months which have elapsed since the person was born; thus a 30-month-old child is one whose age is 30 months or more but is less than 31 months.

4. *Anemia.*—A reduction of the hemoglobin concentration, the hematocrit, or the number of red cells, to a level below that which is normal for a given individual. In this study anemia is defined as a hemoglobin concentration less than 11g/100 ml for infants, children and pregnant women and as a hemoglobin concentration less than 12g/100 ml in the case of postpartum women.

5. *Dietary iron.*—This is used to indicate the total amount of iron in all the foodstuffs eaten by a participant. It includes iron in iron-fortified food items such as iron-fortified cereal and iron-fortified infant formula, but not the iron contained in vitamin/mineral supplements.

6. *Dropout.*—This term is used in two ways in the WIC medical evaluation. "A dropout from the WIC program" is a person who has participated in the WIC program and has not received food and/or vouchers for food for a minimum period of one month. "A dropout from the detailed medical evaluation of the WIC program" is a person who has participated in the detailed medical evaluation and has either withdrawn consent for continued participation or failed to return for a scheduled follow-up visit after a minimum period of two months.

7. *Duration of feeding.*—This term is used interchangeably in this report with the interval between initial enrollment in the program and date of a follow-up visit at which data were collected for the medical evaluation. It is presumed that the participant who showed up for re-examination had been collecting food or vouchers in the interval between visits. Information to check out this assumption was, of course, collected for use in detailed analyses of the data.

8. *Duration of pregnancy.*—The time period between a clinic visit for data collection and the first day of the participants' last menstrual period except that in those cases where this information was not available or could not be reliably obtained, clinical assessment of pregnancy duration (taken from the woman's medical records) was used.

9. *Ethnic origin (race).*—Classification was made by observation of an interviewer. Such factors as general appearance, facial appearance, skin color, surname and speech were considered. The term does not imply genetic background alone. Culture, income, education, access to health services and social program and numerous other factors contribute to ethnic (racial) differences. WIC participants were classified into six ethnic groups: White, black, Spanish-American (Spanish

surnamed), American Indian (Indian), Oriental and others. In some analyses Oriental and Indians were grouped with others if they were too few in numbers to be treated separately.

10. *Gestational interval (gestational age).*—This is the intra-uterine age of a fetus. In this study gestational age is taken as the same time period as the duration of the pregnancy.

11. *Household.*—A group of related or unrelated individuals eating together and sharing the same kitchen facilities.

12. *Income (household, total, earned, after-tax).*—This is the total income of all the members of the household after deduction of all taxes. It is, in other words, the total take home pay for all the members of the household.

13. *Income (real).*—This is the total after-tax income plus the net value of the food stamp allotment for the household. The net value of the food stamps is the value of the food stamps less the amount paid for them.

14. *Income poverty ratio (IPR).*—An index used to relate income and household size to the cost of living.

$$\text{IPR} = \frac{\text{Before tax household income}}{\text{OEO income poverty guideline appropriate for that household}}$$

Since the OEO income poverty guidelines were the same for all the 19 project areas, it is obvious that no allowance was made for local differences in the cost of living.

15. *Nutritional index (NI).*—This is a ratio used to relate weight to height in children.

$$\text{NI} = \frac{\text{Weight in kgs}}{\text{Height in cms}^{3.0}}$$

A high ratio indicates that the child is relatively heavy for his stature while a low ratio indicates that the child is thin.

16.1 *Participant.*—A person eligible to receive food supplements in any one of the 19 projects. The following definitions relate to categories of participants.

16.2 *Infant.*—A participant in the WIC program who was less than 12 months old at the time of the particular clinic visit.

16.3 *Child.*—A participant in the WIC program who was more than 12 months old but not more than 48 months (4 years) of age at the time of the particular clinic visit.

16.4 *Pregnant woman.*—A female participant who was pregnant at the time of the examination.

16.5 *Postpartum woman.*—A female participant who was within six weeks of termination of her pregnancy, except for women who were breast feeding their babies, in which case they were eligible for up to 12 months after delivery. Termination of pregnancy included abortion, miscarriage, stillbirth and live birth.

17. *Pregnancy duration.*—See duration of pregnancy.

18. *Project.*—Any one of the 19 administrative units which provided data for the detailed medical evaluation.

19. *Project site.*—A clinic or other location where data were collected for the evaluation. A project may consist of one or more project sites.

20. *Recommended dietary allowance.*—The daily intake of a nutrient recommended by the Food and Nutrition Board/National Research Council, as adequate to meet the needs of 97.5 percent of individuals in the United States, except for energy. In the case of energy the recommendation is for a healthy, moderately active adult who is neither gaining nor losing weight and for a healthy child who is growing at a satisfatory rate.

21. *Signs.*—

<6 means less than six
>6 means greater than six
6+ means six and greater i.e., including six
6–11 means six up to but excluding twelve except as noted in [1].
$\triangle$ means change in the measured value of a parameter during the stated time period or stated interval between clinic visits e.g., $\triangle_6$ means observed change of a parameter between the initial and the 6-month visits

[1] In the case of women pregnant for 17–28 weeks the cutoff was at 28 weeks; women pregnant for 28 weeks were therefore included in this category and the next group included women >28 weeks pregnant.

22. *Weight/Height Index.*—This is a ratio used to relate weight to height in the women participants.

$$\text{Weight/Height Index} = \frac{\text{Weight in kg}}{\text{Ideal weight for height in kg}}$$

The ideal weight for height is the recommended weight for a given height and is considered to be optimal for health. A high ratio indicates relative overweight while a low ratio indicates that the woman is thin.

APPENDIX I.1

BASELINE ANTHROPOMETRIC DATA FOR ALL BOYS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	11,935	3.30	0.57												
Less than 0.5	497	3.68	1.32	423	51.5	3.8	445	35.7	2.4	412	67.1	9.6	412	13.8	1.7
0.5 to 0.9	501	4.15	1.46	457	53.1	4.1	505	36.9	2.1	451	71.3	9.3	450	14.5	1.6
1	955	4.78	1.13	832	55.4	4.7	947	38.3	2.5	817	77.0	9.9	817	15.4	1.9
2	561	5.64	1.15	513	59.0	4.6	557	39.8	2.1	501	82.9	10.3	501	16.3	2.1
3	402	6.49	1.43	374	62.0	4.4	398	41.1	2.1	369	87.3	9.8	369	16.8	1.8
4 to 5	688	7.45	1.21	640	65.6	4.2	686	43.1	2.3	628	91.8	9.2	629	17.3	1.8
6 to 11	1,914	9.03	1.67	1,702	71.5	4.9	1,812	45.2	2.4	1,665	96.6	10.5	1,667	17.5	1.9
12 to 17	1,470	10.92	1.69	1,354	78.7	5.0	1,404	47.2	2.3	1,322	100.2	10.3	1,328	17.5	2.0
18 to 23	1,518	12.14	1.73	1,382	84.0	5.3	1,464	48.5	2.2	1,352	100.1	10.4	1,356	17.0	1.9
24 to 29	1,373	13.10	1.76	1,260	88.1	6.1	1,321	49.2	2.2	1,231	100.4	9.5	1,233	16.7	1.7
30 to 35	1,329	14.22	2.04	1,223	92.5	5.6	1,287	49.8	2.3	1,188	100.9	9.2	1,193	16.5	1.7
36 to 41	1,184	15.07	2.16	1,099	95.7	7.1	1,143	50.3	2.2	1,068	100.9	9.9	1,070	16.3	1.6
42 to 47	734	15.85	2.12	693	98.1	5.9	708	50.5	2.3	671	100.9	9.0	671	16.1	1.4

APPENDIX I.2

BASELINE ANTHROPOMETRIC DATA FOR ALL GIRLS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	11,344	3.18	0.55												
Less than 0.5	436	3.52	.82	353	51.3	5.0	387	35.1	1.9	342	66.2	8.7	347	13.6	1.5
0.5 to .0.9	423	3.90	.63	391	52.1	4.3	425	36.1	2.0	378	70.3	9.1	378	14.4	1.6
1	880	4.46	.85	779	54.6	4.3	870	37.5	2.2	705	74.1	10.0	702	14.9	1.8
2	963	5.34	.96	817	57.9	3.8	905	39.2	2.4	510	80.3	9.7	510	15.8	1.9
3	379	6.02	1.31	354	60.8	4.6	378	40.2	2.1	351	83.3	9.8	349	16.2	1.8
4 to 5	665	6.81	1.11	535	64.2	4.8	657	41.8	2.3	488	87.5	9.2	488	16.6	1.7
6 to 11	1,680	8.53	1.57	1,562	70.3	5.1	1,605	44.2	2.3	1,522	94.1	10.3	1,519	17.2	1.9
12 to 17	1,498	10.31	1.71	1,390	77.2	5.4	1,404	46.2	2.1	1,308	97.2	10.6	1,310	17.1	1.9
18 to 23	1,442	11.63	1.86	1,319	83.1	4.9	1,398	47.4	2.0	1,283	97.6	10.8	1,281	16.7	1.9
24 to 29	1,336	12.57	1.82	1,230	87.1	6.2	1,289	48.0	2.0	1,191	97.9	10.0	1,192	16.4	1.7
30 to 35	1,247	13.51	1.97	1,135	91.1	6.0	1,181	48.7	2.2	1,098	97.8	10.0	1,101	16.1	1.7
36 to 41	1,216	14.53	2.24	1,117	95.2	6.2	1,180	49.1	2.4	1,084	98.2	10.3	1,083	15.9	1.6
42 to 47	731	15.27	1.99	651	98.0	7.1	698	49.5	2.3	635	98.6	10.0	634	15.8	1.9

APPENDIX I.3

BASELINE ANTHROPOMETRIC DATA FOR WHITE BOYS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	2,645	3.33	0.57												
Less than 0.5	112	3.55	.63	95	52.0	3.4	102	35.5	1.9	93	66.1	7.2	93	13.6	1.5
0.5 to 0.9	88	4.46	3.00	81	53.7	2.6	97	37.3	2.6	79	71.1	7.5	79	14.5	1.5
1	219	4.84	1.17	200	55.6	4.5	213	38.5	2.5	198	75.7	10.7	197	15.3	1.9
2	152	5.51	1.21	145	58.9	4.0	150	40.0	2.0	142	80.4	10.0	141	15.8	1.8
3	96	6.30	.83	93	61.6	3.0	96	41.0	1.5	92	85.9	8.0	92	16.5	1.5
4 to 5	159	7.33	1.03	142	65.7	4.2	157	43.1	1.6	140	90.4	8.2	141	17.1	1.8
6 to 11	412	8.93	1.52	380	71.3	5.0	407	45.3	2.4	382	96.4	10.7	383	17.5	2.0
12 to 17	323	10.01	1.90	301	78.4	5.3	317	47.2	2.5	293	99.2	10.2	294	17.4	2.0
18 to 23	275	11.95	1.52	245	84.2	4.8	268	48.5	2.1	241	98.7	9.8	241	16.8	1.7
24 to 29	274	12.95	1.60	254	87.8	5.6	270	49.5	1.6	250	99.8	8.9	250	16.7	1.5
30 to 35	260	13.96	1.76	244	92.6	4.1	260	50.0	1.5	242	99.8	8.5	243	16.3	1.6
36 to 41	242	14.95	2.12	225	95.7	7.1	239	50.5	2.2	222	100.0	9.2	222	16.1	1.4
42 to 47	144	15.39	2.24	139	98.5	6.0	138	50.5	2.4	139	96.3	9.5	139	15.9	1.6

APPENDIX 1.6

BASELINE ANTHROPOMETRIC DATA FOR [illegible] GIRLS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	2,573	3.23	0.54												
Less than 0.5	108	3.53	.56	72	51.4	3.1	88	35.0	1.9	70	66.0	7.7	71	13.6	1.6
0.5 to 0.9	76	3.87	.61	72	52.9	2.4	74	36.2	1.7	68	68.1	8.2	69	14.2	1.8
1	208	4.51	.70	182	54.9	2.4	198	37.7	1.7	179	75.0	10.5	179	15.1	2.1
2	147	5.28	.90	133	57.5	2.9	147	39.2	2.0	132	79.8	10.6	132	15.8	2.0
3	102	5.73	1.11	92	60.4	3.1	102	40.1	2.1	92	86.7	9.1	92	15.6	1.7
4 to 5	154	6.73	1.30	147	64.3	5.8	155	41.8	2.6	143	86.2	8.2	143	16.3	1.5
6 to 11	371	8.46	1.52	345	70.4	5.3	368	44.3	2.1	340	93.1	9.3	339	17.0	1.6
12 to 17	322	10.15	1.47	286	77.7	4.7	313	46.1	1.9	292	95.8	9.5	292	16.8	1.7
18 to 23	291	11.31	1.68	257	82.9	4.1	276	47.2	1.9	253	96.1	10.4	253	16.4	1.8
24 to 29	247	12.34	1.65	225	86.3	4.4	240	48.0	1.9	218	97.5	10.6	218	16.4	1.8
30 to 35	253	13.35	1.77	228	90.0	4.9	248	48.8	1.8	224	97.7	9.9	225	16.2	1.9
36 to 41	250	14.37	1.88	227	94.0	5.4	245	49.2	1.9	225	98.3	8.7	225	15.9	1.5
42 to 47	175	15.22	1.97	150	96.6	6.6	171	48.4	1.9	167	99.4	10.1	167	15.9	1.7

APPENDIX I.5

BASELINE ANTHROPOMETRIC DATA FOR BLACK BOYS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	4,015	3.18	0.56												
Less than 0.5	144	3.46	.54	106	50.2	3.6	113	35.1	2.6	101	97.9	12.9	100	13.8	1.7
0.5 to 0.9	148	3.99	.83	129	52.1	4.4	150	36.6	2.3	121	71.5	11.0	121	14.6	1.8
1	380	4.36	.99	303	54.6	4.5	380	38.1	2.4	297	76.5	9.5	298	15.4	1.8
2	180	5.71	1.05	150	58.9	5.8	181	38.7	2.1	143	85.2	10.4	144	16.9	2.3
3	133	6.41	1.09	114	61.8	5.6	130	40.0	2.6	112	86.6	11.1	112	16.7	2.1
4 to 5	282	7.27	1.18	185	65.0	3.7	284	43.0	2.4	178	91.1	9.4	179	17.2	2.0
6 to 11	529	9.05	1.62	481	71.8	4.8	534	45.2	2.3	464	96.3	11.9	464	17.4	2.2
12 to 17	471	10.94	1.57	413	78.8	4.7	411	47.4	2.7	387	99.7	10.1	401	17.5	2.1
18 to 23	499	12.14	1.82	446	84.0	6.1	453	48.7	2.5	429	99.7	10.7	429	17.0	1.9
24 to 29	444	13.26	1.77	390	88.9	6.6	399	49.5	2.7	374	100.0	9.6	374	16.6	1.6
30 to 35	427	14.12	1.96	377	93.3	5.9	384	49.9	2.9	358	100.7	9.1	359	16.4	1.6
36 to 41	396	15.00	2.12	362	96.8	8.7	358	50.4	2.6	338	99.8	9.6	338	16.0	1.5
42 to 47	275	15.29	1.95	268	100.9	8.4	257	50.9	2.6	247	100.9	8.4	247	15.9	1.3

APPENDIX 1.6

BASELINE ANTHROPOMETRIC DATA FOR BLACK GIRLS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	4,008	3.04	0.53												
Less than .5	122	3.30	.50	186	50.5	6.0	68	35.0	1.9	70	66.0	7.7	60	13.5	1.5
0.5 to 0.9	132	3.80	.55	114	51.4	4.1	138	35.7	1.9	107	68.7	7.4	101	14.5	1.6
1	251	4.38	.66	288	54.0	4.2	344	37.2	2.4	298	73.0	9.2	279	14.8	1.7
2	186	5.22	.87	159	57.2	3.8	183	38.2	2.2	155	80.5	9.6	154	15.8	1.6
3	113	6.11	1.10	102	60.3	3.7	112	40.2	2.2	90	84.2	10.8	90	16.4	2.0
4 to 5	197	6.68	.98	170	63.5	4.9	201	41.9	2.3	166	88.6	9.6	166	16.4	1.8
6 to 11	541	8.36	1.54	483	70.3	5.6	552	44.4	2.5	467	92.9	10.9	465	17.0	2.0
12 to 17	488	10.38	1.64	453	77.3	6.2	443	46.4	2.6	429	97.0	11.1	428	17.0	2.0
18 to 23	461	11.61	1.79	411	83.3	6.7	424	47.7	2.7	398	97.2	11.5	388	16.6	2.0
24 to 29	451	12.50	1.72	405	87.5	7.5	407	48.3	2.7	388	97.4	9.2	381	16.3	1.7
30 to 35	414	13.62	2.00	373	91.7	7.7	365	49.0	2.8	349	97.4	11.4	350	16.0	2.0
36 to 41	295	14.67	2.28	262	96.0	8.2	268	49.5	2.6	233	97.3	10.2	234	15.7	1.9
42 to 47	280	15.47	1.98	241	98.7	7.8	252	50.1	2.7	231	97.2	10.1	230	15.4	1.6

APPENDIX 17

BASELINE ANTHROPOMETRIC DATA FOR SPANISH-AMERICAN BOYS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	4,814	3.37	0.57												
Less than 0.5	214	3.88	1.08	206	55.7	3.9	214	38.1	2.4	202	97.4	8.8	200	13.9	1.8
0.5 to 0.9	246	4.13	.83	239	53.3	4.4	240	36.0	1.9	233	73.1	9.1	232	14.4	1.4
1	238	4.88	1.15	203	55.7	4.5	229	38.3	2.0	208	77.4	9.8	208	15.1	1.8
2	219	5.66	1.20	208	58.1	4.2	215	39.8	2.2	208	80.4	10.3	208	16.2	1.9
3	157	6.65	1.29	151	62.3	4.3	156	41.3	1.8	148	86.6	9.3	147	17.0	1.7
4 to 5	298	7.66	1.33	286	66.0	4.6	296	43.1	2.0	280	89.0	9.7	282	17.4	1.7
6 to 11	814	9.06	1.77	772	71.3	4.8	812	45.1	2.4	760	96.9	9.5	761	17.6	1.7
12 to 17	627	10.96	1.69	583	78.7	5.0	627	47.2	2.0	586	101.1	10.6	586	17.7	1.9
18 to 23	598	12.18	1.74	568	83.9	4.9	598	48.2	1.9	558	100.7	10.3	556	17.1	1.8
24 to 29	514	13.02	1.78	478	87.0	5.0	512	48.8	1.9	471	100.7	9.5	472	16.8	1.7
30 to 35	573	14.20	2.26	543	90.0	5.0	572	49.5	2.0	530	101.2	9.6	533	16.7	1.8
36 to 41	488	15.03	2.29	459	93.4	5.1	488	50.0	1.9	458	101.7	10.4	457	16.9	1.8
42 to 47	283	15.62	2.17	264	97.7	5.3	281	50.2	1.7	268	101.8	9.4	265	16.3	1.5

APPENDIX I.8

BASELINE ANTHROPOMETRIC DATA FOR SPANISH-AMERICAN GIRLS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	DS
0	4,484	3.26	0.55												
Less than 0.5	283	3.66	1.04	190	51.5	5.1	199	35.4	2.0	185	66.8	9.8	188	13.7	1.5
0.5 to 0.9	208	3.98	.61	188	52.3	3.4	205	36.4	2.1	188	71.0	10.2	197	14.4	1.6
1	306	4.55	.80	288	54.9	4.6	305	37.6	2.2	285	74.4	10.4	283	14.9	1.7
2	213	5.47	1.04	202	58.7	3.7	212	39.2	1.9	200	80.5	9.3	201	15.9	2.1
3	151	6.12	1.42	147	61.3	5.4	151	40.3	2.0	147	84.1	9.5	145	16.3	1.7
4 to 5	290	6.94	1.09	281	64.5	4.3	299	41.8	2.1	278	88.6	9.5	277	16.8	1.8
6 to 11	709	8.67	1.63	668	70.2	4.7	709	44.1	2.2	659	95.4	10.3	650	17.4	1.9
12 to 17	594	10.35	1.74	558	76.8	5.2	588	46.0	2.0	530	98.3	10.6	541	17.3	2.0
18 to 23	645	11.75	2.00	602	83.1	4.7	643	47.1	1.9	591	98.5	10.5	591	16.8	1.8
24 to 29	580	12.62	1.98	553	87.2	5.1	581	47.8	1.9	542	98.4	10.4	542	16.5	1.7
30 to 35	534	13.51	2.01	496	90.8	5.1	525	48.3	1.9	488	98.1	10.2	488	16.1	1.7
36 to 41	530	14.44	2.36	502	94.1	7.0	533	48.8	2.2	490	98.6	10.9	488	16.0	1.7
42 to 47	305	15.11	2.03	280	97.1	5.7	305	49.1	2.0	277	98.5	9.9	277	15.9	1.6

APPENDIX I.9

BASELINE ANTHROPOMETRIC DATA FOR AMERICAN INDIAN BOYS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	276	3.48	0.56												
Less than 2.5	15	3.98	.45	15	54.1	2.9	15	36.8	1.4	15	68.7	5.6	15	13.3	1.2
0.5 to 0.9	13	4.20	.37	13	53.9	1.7	14	37.4	1.6	13	71.4	6.9	13	14.5	1.3
1	21	6.11	2.64	21	59.1	8.6	20	39.5	2.9	19	80.9	10.7	19	15.9	1.8
2	10	6.05	.49	10	60.8	2.4	10	43.9	1.4	10	84.7	7.1	10	16.4	1.5
3	12	7.03	1.21	12	64.3	2.2	12	42.1	1.4	12	89.7	14.2	12	17.0	2.7
4 to 5	18	7.43	.62	17	65.5	2.5	18	43.4	1.3	17	91.8	6.1	17	17.3	1.2
6 to 11	46	9.62	1.90	45	73.8	6.3	45	46.1	1.9	45	98.0	10.3	45	17.6	1.8
12 to 17	40	10.97	1.30	38	79.2	3.7	40	47.3	1.7	38	100.7	8.9	38	17.5	1.6
18 to 23	45	12.14	1.49	42	86.1	2.9	44	49.3	2.0	42	102.4	11.2	42	17.2	1.9
24 to 29	33	13.92	2.01	31	88.8	7.9	32	50.3	2.7	29	103.0	11.4	30	17.4	2.9
30 to 35	50	14.75	1.53	47	91.9	9.1	48	50.8	1.7	46	104.6	8.1	46	17.1	1.3
36 to 41	44	15.82	1.79	41	97.2	3.5	44	51.0	1.2	41	103.9	6.7	41	16.7	1.1
42 to 47	24	16.55	1.59	21	100.1	3.6	24	50.8	2.5	21	102.7	6.7	21	16.3	1.5

APPENDIX 1.10

BASELINE ANTHROPOMETRIC DATA FOR AMERICAN INDIAN GIRLS

Age in months	Weight (kilograms)			Height (centimeters)			Head circumference (centimeters)			Nutritional index			Body mass index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
0	233	3.33	0.52												
Less than 0.5	4	3.62	.96	4	51.1	0.8	4	35.2	1.0	4	66.9	11.6	4	13.9	2.3
0.5 to 0.9	4	4.03	.13	3	53.1	1.2	4	37.1	0.6	3	73.9	8.8	3	14.3	1.4
1	15	5.42	0.95	13	58.6	10.9	14	39.5	0.6	13	77.8	8.8	13	15.8	2.4
2	18	5.34	.78	18	57.8	2.9	18	38.3	0.8	18	80.6	8.8	18	15.9	2.1
3	9	6.60	1.50	9	63.3	6.6	9	41.0	0.8	9	88.5	7.0	10	16.3	2.1
4 to 5	20	6.88	.80	10	64.1	2.8	10	41.9	0.7	9	88.1	7.0	9	16.7	1.5
6 to 11	43	8.95	1.25	41	70.9	3.6	41	43.6	0.8	39	88.2	7.0	39	17.7	1.6
12 to 17	44	10.38	1.47	43	78.3	3.7	43	46.4	0.8	43	90.3	8.1	43	17.0	1.6
18 to 23	36	12.05	1.33	33	82.6	2.6	35	47.7	0.9	33	90.6	10.4	42	17.6	1.6
24 to 29	45	12.85	1.47	46	88.0	2.9	43	48.3	1.0	33	93.0	9.3	32	16.6	1.6
30 to 35	34	13.76	1.97	30	90.9	5.7	34	49.3	1.3	30	96.7	8.7	30	16.6	1.6
36 to 41	31	15.22	1.73	29	94.6	2.9	30	49.3	1.4	29	100.7	11.1	29	16.6	1.6
42 to 47	18	15.51	1.39	17	98.6	2.9	18	50.3	1.4	17	100.0	6.8	17	15.9	1.6